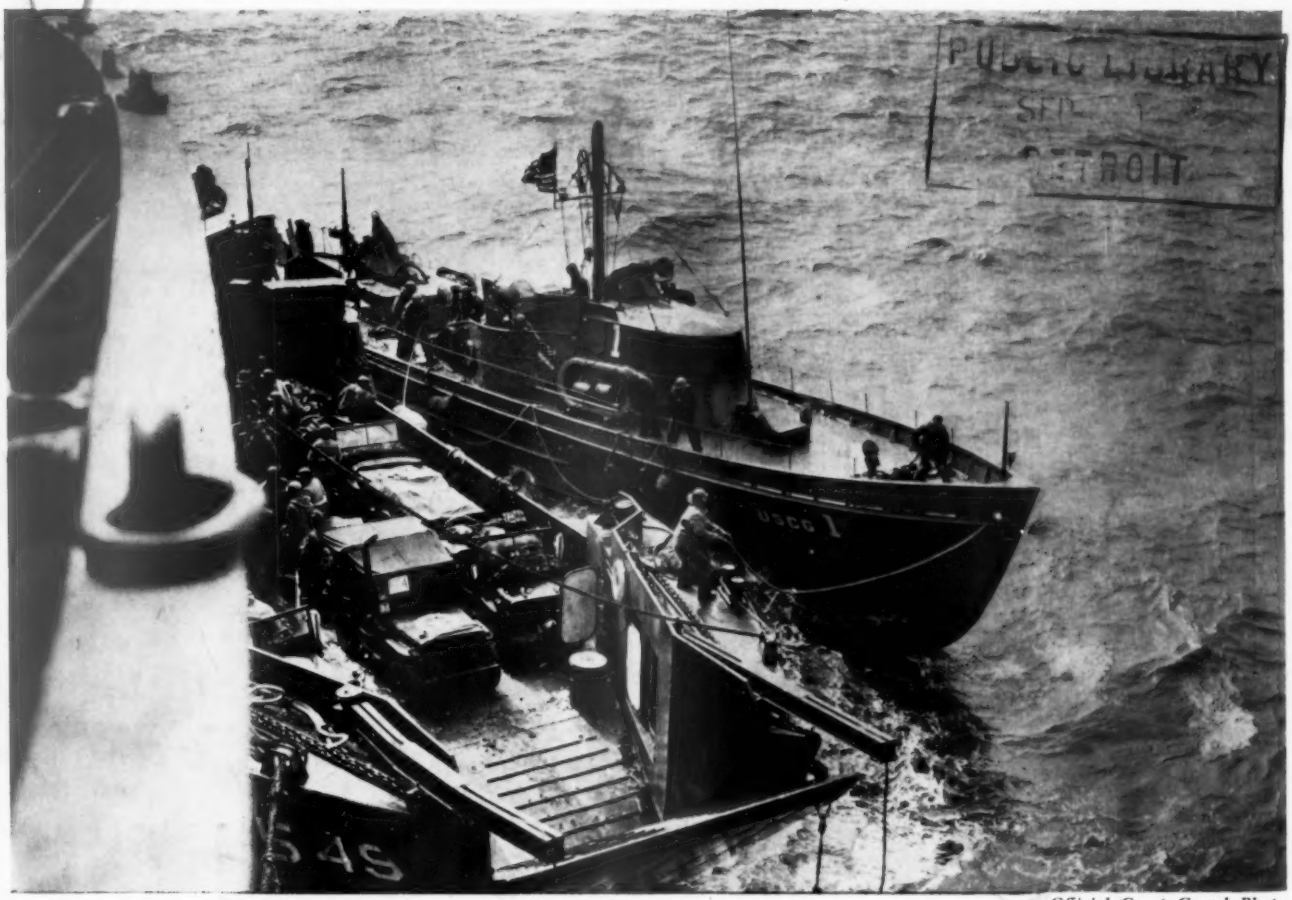
NATIONAL PETROLEUM NEWS

September 6, 1944

TECHNOLOGY DEPT:

Sub Busters Gain New Laurels in Battle To Liberate Europe



Official Coast Guard Photo

The full story concerning the Allied solution to the problem of supplying the invasion armies probably will not be told until after the war ends. But it is safe to assume that the sleek, fast little 83 footers of the U. S. Coast Guard, shown here, will have a high place in that story. During the D Day sweep across the English Channel these intrepid little craft were busy as they had been earlier, in protecting vital armored equipment, men, and fuel. Earlier in the war they earned the name of "sub-buster"

In This Issue—

Petroleum for Peace: Early relaxation of war-time controls with end of European war promised by WPB. **Details on Page 3.**

Fire Protection for POL Depots: Another article from England by Warren C. Platt, NPN's editor. **See Page 6.**

Employing Returning Vets: Draft official tells how laws are operating to give soldiers fresh start. **See Page 24.**

Equipment Survey: Another report from Staffer Earl Lamm on requirements in Central Illinois. **See Page 18.**

NPN Overseas Edition for Oil Men In Service

CLEVELAND—Oil men engaged in the titanic job of supplying Allied armed forces with petroleum products in the battle areas are eager for news from home. They want to know what is happening within the industry in the U. S.; what plans are being made for the postwar era, and what obstacles are being overcome in stepping up production for war.

Realizing this need among oil men with the armed forces, NPN has launched a new wartime enterprise. An overseas edition is being compiled each week. It is sent by air mail to oil men in the European war theaters.

The Overseas Edition of NPN not only brings news of the industry in condensed form to industry men and technicians on the war fronts. It brings the story of what the men in the battle areas are doing to win the war. This latter achievement is being reported by Warren C. Platt, editor and publisher who has gone to Europe to get and report this news. His on-the-scene observations are carried fully in the Overseas Edition.

REFINERY MANAGEMENT AND PETROLEUM CHEMICAL TECHNOLOGY EDITION—In 2 Sections, Section 1

Accurate fueling of America's cargo planes

INSURES MAXIMUM PAYLOADS

PHOTO COURTESY OF WHITE MOTOR CO

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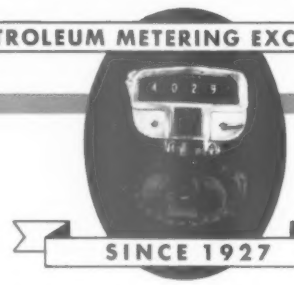

SINCE 1927

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It takes more than a potato . . .

It takes more than a potato **to seal an oil can, these days. But, full credit to the spud for a job well done. Early America sealed its oil cans that way and no more was needed. Today, America seals its oil in drums and cans with assurance of full, untampered delivery after heavy handling on long troubled trips.** ***Yes, it takes more than a potato . . .***

These two cans are war cans, utilizing VISEGRIP CLOSURES for fast and safe sealing and emptying.

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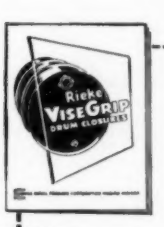
Every drum manufacturer and many can companies in the United States are equipped with Rieke dies and stocks of VISEGRIP fittings. They will build VISEGRIP CLOSURES into the drums and cans on your orders.

"ViseGrip Drum Closures," our full-sized catalogue, is available upon request. Please use the coupon to get your copy.



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Texaco Safety Engineer Honored by U. S.

Governor Stevenson J. S. Leach Charles A. Miller

CHARLES A. MILLER (right) of Houston, safety engineer for The Texas Company, is shown receiving a special citation from Governor Coke Stevenson of Texas (left) who delivered it at the request of Secretary of Labor Frances Perkins. J. S. Leach, vice-president of The Texas Company, looks on.

Miss Perkins in her citation said that for four years Mr. Miller has been acting as volunteer special agent for the Department of Labor, and has directed the field operations of Committee on Conservation of Manpower in War Agencies (Region VII). Miss Perkins wrote the Governor that it would be impossible for her to present the award personally, and asked that he serve for her.

The Secretary stated that Mr. Miller "has played an important role in the war effort by materially reducing the loss of valuable production time due to work accidents . . ."

The citation was in the form of a certificate and service bar.

Region VII consists of Texas, Louisiana, Arkansas, Oklahoma and New Mexico, an area of relatively new and rapidly developing industry.

Under Mr. Miller's direction, special agents in this region made some 1600 safety service calls on 650 individual establishments; completed more than 1000 special assignments such as appearances before public and private groups to further safety activity. Nearly 6000 supervisory employes in war plants were instructed in industrial accident prevention.

Miss Perkins' statement revealed 86.1 per cent of the plants reporting in the area showed a marked decrease in the accident rate since receiving this safety service.

Thanks from Industry —

For a Job Well Done

In Government Service

TO:

DENE B. HODGES, who has returned to Shell Oil Co., in New York, after an outstanding piece of work as associate director of PAW's Supply and Transportation Division.

Mr. Hodges came to PAW early in the current year and played a prominent part in organizing the eastward flow of petroleum war products that fueled the invasion of Europe.

A veteran of more than 18 years in oil, Mr. Hodges got his start in the industry back in 1926 when he went to work as a clerk in the production department of Shell's field office at Ventura, Calif. He had attended the University of Nebraska, where he majored in chemistry, and it had been his plan to enter laboratory work for the oil industry in California. However, he was destined to become associated with the commercial aspects of the business.

In 1929 the Shell Company assigned him to its Martinez refinery where he spent the next five years in product accounting and operating estimates work. In 1934, Mr. Hodges joined the company staff at San Francisco as administrative assistant in the manufacturing department, where he was in charge of operating estimates for the Pacific Coast area. During part of 1939 and early 1940 he was executive assistant, dealing mainly with production problems.

In February of 1940 he joined the New York City staff of Shell as manager of supplies for the Atlantic Coast area and then became manager for the combined Mid-Continent and Atlantic Coast areas, and manager of transportation and supplies for the combined areas.

Mr. Hodges was born January 18, 1905, at Holdredge, Neb. He is married and has two children.

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"Petroleum for Peace" Is Forecast With End of European War

Rapid Cancellation of All Government Controls Is Prediction As Result of WPB Decision To Eliminate Most Restrictions

By Herbert A. Yocom
Chief, NPN Washington Bureau

WASHINGTON—Cancellation by the end of the year of all government controls on the oil industry's use of steel was forecast here this week as a result of a WPB decision to eliminate "almost all controls" on civilian production immediately after the defeat of Germany.

According to the formal announcement of the WPB action by Acting Chairman J. A. Krug, the official program is to continue the Controlled Materials Plan for allocating steel "only for the quarter in which hostilities in Europe cease."

Simply stated, this means that if Germany falls in October, November or December, controls on the use of steel will go out the window on next January 1, and, with them, PAW's companion well-spacing and other orders. To stretch things a bit, it could even mean an end to CMP for steel by October 1, although only the most optimistic here are looking for Germany to drop out of the war in this, the last month of the third quarter.

Industry's Own Initiative

Prompting the unanimous WPB vote authorizing virtually unrestricted civilian production was the board's earlier finding that there will be a 40% reduction in war production within three months after Germany falls, creating a demand for new jobs for more than 4,000,000 workers.

"This means," said Acting Chairman Krug, commenting on the action, "that all manufacturers can use any plant and any materials that are not needed for military production for any civilian production."

Industry, he added, "is to be allowed in its own way, according to the availability of markets, men, materials and plants to do the swiftest and most effective job possible of restoring production, making whatever people want and affording maximum employment, just as quickly as possible."

The only controls retained, Mr. Krug said, will be those "that are absolutely necessary to assure the reduced measure

(*Continued on p.* 54)

Dewey Sees Ample Demand for Crude and Synthetic Rubber

NPN News Bureau

WASHINGTON—In a special synthetic rubber report released this week—his last before the abolition of the rubber director's office — Col. Bradley Dewey predicted that the postwar world demand will be so large that there will be need for all the crude rubber present plantations can turn out and also the output of the low-cost producers of the synthetic rubber program—from 400,000 to 600,000 tons. "There should be no duties or subsidies or international agreements," he said.

Col. Dewey's last report, labeled a "special report," was broken down into two parts: One described in minute detail the plant investment and production costs involved in the U. S. rubber program, the other—Appendix A—took the form of an analysis by Everett G. Holt, chief of the commercial research division of the Rubber Development Corp. of certain data on the prewar costs of production for plantation rubber. (*Full text of Col. Dewey's report will appear in next week's NPN.*)

Ask Postwar Intention of U. S. Plant Operators

NPN News Bureau

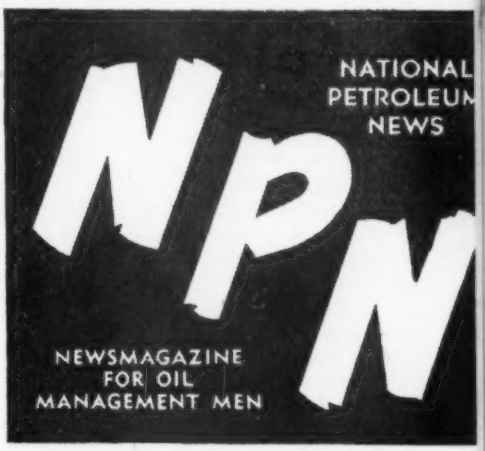
WASHINGTON — Jesse Jones this week asked each of the 376 industrialists operating 586 government-owned war plants to let government know immediately whether they contemplate acquiring the property for postwar civilian activities so that plans might be made now to keep as many in production as possible.

Following is text of wire sent out by Mr. Jones to operators of plants financed at a total cost to the government of $4,720,000,000.

"While we do not know how soon the Defense Plant Corp. buildings which you are leasing will become surplus to the war effort, we would like to know whether or not you contemplate acquiring the property for postwar civilian activities, either under your option or through negotiation. I am sure you can understand the problems which will confront all of us, and that you want to do everything you can to prevent unemployment in the reconversion period. We will greatly appreciate your co-operation by advising us as quickly as possible. We need the information to aid us in planning to keep as many of the properties as possible in production either through sale or lease."

The 586 plants, Mr. Jones emphasized, are complete units, land, buildings, machinery and equipment being owned by DPC, and are distinguished from plants where DPC has added buildings, equipment and facilities to privately owned plants.

Some of the plants are operated for account of RFC agencies, and others are under lease to operators. Leases provide for cancellation when the product is no longer needed in the war effort.



Tire Crisis Hits Trucks Hauling Aviation 'Gas'

By James Collins
NPN Staff Writer

WASHINGTON—ODT Director Johnson this week reported that widespread curtailment of essential truck services—including a "considerable number" which haul aviation gasoline to airfields—has already taken place because of the shortage of heavy duty tires.

Although such operations have been given the highest tire priority, Mr. Johnson pointed out, "tank truck operators frequently cannot obtain tires after they have secured certificates."

Mr. Johnson pointed out the serious tank truck situation in announcing fourth quarter allocations of heavy duty tires by WPB, which, he said, will force a continuation of the severe shortage of such tires for replacement purposes through October, November and December. A spread of the tire shortage to the smaller size truck tires is also in prospect, he added.

Allocations Below Need

Fourth-quarter tire allocations by WPB for October, November and December were far below basic requirements on tires in sizes 8.25-20 and up, Mr. Johnson said, because of the decision to satisfy expanded military requirements. After an appeal by ODT from "the unsatisfactory allocation," he added, "WPB increased the heavy-duty allotments only slightly and made a drastic cut in the smaller size truck tire allotments."

Allotment of tires for replacement purposes reflects "drastic curtailment" by ODT in its assignment of tires for new vehicles, the ODT director said. The number of tires actually assigned for original equipment on new vehicles in the fourth-quarter is 206,056, which represents a 35.4% decrease from the amount originally requested to meet the new vehicles program in full.

"Also, the volume of tires remaining for replacement purposes will permit rationing at the rate of only 96,832 tires in sizes 8.25 x 20 and larger per month," Colonel Johnson said.

Meek Says Price Panels Have Too Much Power; Asks OPA To Warn Local Members

NPN News Bureau

CHICAGO — Citing six ways in which members of local OPA price panels have what he termed "the power of life and death" over the business institutions of Illinois, J. T. Meek, executive secretary of the Illinois Federation of Retail Associations, asked the help of Marion Isbell and Carter Jenkins, Chicago and downstate OPA officials, in impressing local price panel members with "full realization of what their procedure might bring in their efforts to carry out the OPA mandate."

What he referred to as the six weapons which local panels now have at hand to secure enforcement of price orders, authorized to local boards on Aug. 22, are:

1. To make court action unnecessary in minor violation, the administrator has now directed price panels to act for him in negotiating with retailers for an agreed settlement, providing a return of overcharges and, in some cases, the payment of a small penalty to the treasury.

2. In cases of unintentional violations the price panels may, if they believe the circumstances warrant, close the case with an agreement from the retailer to comply in future sales. In more serious cases, the price panel may request settlement at amounts up to three times the overcharge or $50, whichever is greater.

3. If the price panel finds that records are falsified, payments were made on the side, or the violations were repeated after a warning from OPA, the price panel is to send the cases directly to the district office for handling.

4. If the overcharged customers can be identified, the money is to be returned to them. If they cannot be identified, the payment is to the United States Treasury. In no case will OPA obtain a refund for the customer in excess of the overcharge to him. If the customer wishes to sue for treble damages, he must do so before OPA takes actions.

5. In any case where payment is to be made to the Treasury, a district OPA office must approve the agreement reached by the price panel and the retailer before the payment is completed and the case closed.

6. Negotiation with the price panel on the part of the retailer is voluntary throughout. If the retailer is unwilling to agree to a voluntary settlement in place of formal court action, the price panel will send the case to district enforcement officials for handling.

"These panel members now have the opportunity to secure full and friendly compliance with price control or to alienate retailers of the State through misguided witch hunts and lack of understanding of what unfair and uncalled-for publicity can do to years of conscientious effort on the part of law abiding, community building, tax paying American citizens," Meek stated in a letter to the OPA officials.

Speaking for association members of the federation, among them the Gasoline Retailers Association of Metropolitan Chicago, he stated that these powers place a great burden on the volunteer member of a local price panel and call for a great deal of restraint, consideration and actual sympathy for those who are doing their best to control prices under orders which are extremely perplexing and hard to follow.

Claims OPA Counterfeit Drive Curbs 'Gas' Black Market

NPN News Bureau

CHICAGO—OPA's recent "all out" against gasoline coupon counterfeiters and peddlers has resulted in greatly curbed operations in illicit motor fuel and has brought price of black market gasoline up to 60 cents a gal. in the Midwestern region, Rae E. Walters, regional OPA administrator stated this week.

"One informant told us he was charged $9.00 for 15 gals. And we've also heard of charges of 30 to 55 cts. each for black market coupons. All of this reflects the effectiveness of the current enforcement activities against this type of illegal market," Mr. Walters continued, adding that credit must be given, too, to the great majority of citizens who have complied with gasoline rationing regulations.

Mr. Walters added his belief that considerable decrease in highway traffic over Labor Day this year over that of last year, as reported by officers of the Illinois State Highway Patrol and Cook County Police, is also due in part to OPA's clamping down on counterfeit operations.

New Avenue to Black Market Is Seen in Chicago Case

NPN News Bureau

CHICAGO—A new idea in gasoline black market operations was advanced last week when a service station operator who had been debited for 500 gals. of gasoline for allegedly turning in counterfeit inventory coupons vehemently denied the charge and OPA turned to investigation of possibility of tank wagon drivers cutting themselves in on black market operations by purchasing counterfeit coupons and turning them in on gummed sheets to their company for gasoline in the name of the companies to which they deliver. Such a racket would net drivers large quantities of gasoline on which they could make a considerable profit.

The station operator, operator of a garage in Chicago and a commander in the Coast Guard Reserve, stated he is prepared to prove that he never handled inventory coupons of the 100 gal. size involved and that the writing on the gummed sheet is not his nor that of any of his employees.

OPA has unofficially admitted it is inclined to believe his denials because of results of current investigations and is now looking into other cases for possibilities of the tank wagon driver being the guilty party. Official decision, however, has not yet been given.

OPA Posters Weapon in Fight Against Black Market

"MY TANK'S IN THE WAR, TOO...
GAS
and I'm running it fair and square to protect your share"
We sell gasoline only if you have legally issued coupons properly endorsed.
HELP US SMASH THE BLACK MARKET!

The posters reproduced here were designed as a weapon to help smash the black market in gasoline. Issued by OPA, they explain their own purpose. Posters such as these will soon appear in service stations from coast to coast. OPA says of them that they are expected to accomplish two things: Head off requests of motorists for gasoline when such motorists do not have proper coupons, and to "increase the respect for the honest dealer in the eyes of the public"

Gas Output Regulations Set for Two Fields By Texas Commission

Special to NPN

AUSTIN—The Texas Railroad Commission has set up production rules for the Agua Dulce and Stratton gas fields on the Gulf Coast designed to maintain gas pressures in these fields, considered the most important on the coast.

These two fields will supply most of the gas the Tennessee Gas & Transmission Co. will use to operate its big pipeline to the eastern seaboard, which is expected to begin operations this winter. The Agua Dulce is in Nueces County and Stratton lies in Nueces, Jim Wells, and Kleberg Counties. The Commission stated that the regulations are intended to limit transfer of gas from one reservoir to another after liquid elements have been removed by recycling plants. The order is precedented by one recently issued for the Lake Creek Field in Montgomery County.

The Commission did not set up any pressure minimum or level, but specified that the pressures must be maintained at a high enough point to keep heavy hydrocarbon elements from dropping out inside the reservoir and thus causing preventable waste. Sands affected at Agua Dulce are the Bentonville, Comstock, the 4900 foot, the 5000 foot, the 5100 foot, the South Sponberg Segment, and the East Middle Austin. At Stratton, the sands are the West Upper Austin, the West Middle Austin, and the West Lower Austin.

Oil Sands Specified

The Commission specified as oil sands the upper, middle and lower rivers and Gardner (Wardner) of Agua Dulce; the Bertram, the Wardner, and the West Sellers of Stratton Field. For these, it set an oil-gas ratio of 2750 cubic feet of gas per barrel of oil produced.

Other sands of the field have special regulations; and for the Dabney sand, Agua Dulce field, the Commission reduced the daily allowable from 25 to 20 million feet because bottomhole pressures are declining.

The Commission ordered operators of gas wells in the two fields to make status reports within 30 days and to make quarterly bottomhole pressure tests in March, June, September and December.

The allowable for the sour gas area in the Panhandle was set at 716,548,000 cubic feet daily.

Daniel Cunningham Dead; Former Cashier of Ohio Oil

FINDLAY, Ohio — Daniel Cunningham, former cashier of the Ohio Oil Co. here died on Aug. 30 in a Toledo hospital after an illness of two months.

He was the father of seven sons, six of whom are living, and seven grandchildren.

Mr. Cunningham, 79, was born in New York state, and moved here from Oil City, Pa. in 1907. He retired as cashier of Ohio Oil Co. in 1935. He was a past state treasurer and state secretary of the Knights of Columbus.

Carriger in New Post for Erie

NPN News Bureau

CLEVELAND—A. D. (Dud) Carriger has assumed his new duties as assistant manager of sales of the Erie Meter Systems, Inc., Erie, Pa. Mr. Carriger has been with the Erie company for 30 years.

Profile in Oil

Finding Crude Keeps Weger Busy

When L. T. (Curly) Weger was a kid in the oil fields around Flat Rock, Ill., where he was born on Nov. 12, 1903, and which is just south of Robinson, he had a lot of curly, dark brown hair. He has since lost the hair but the nickname stuck so that not many of his friends recognize his initials alone.

On April 18, 1942, he came to Chicago from Robinson to attend a three-day meeting at Dist. 2 industry headquarters on South Michigan Blvd. as a representative of Ohio Oil Co. Figuring that there is no way of telling what industry meetings will turn into, he was prepared to stay a whole week. But it was even more eventful than that—he's been in Chicago now nearly 2½ years. He is on leave from his company, where his title was and still is "special representative."

L. T. (Curly) Weger

Refineries were short of crude oil when he arrived in Chicago and he became a crude oil bird dog. In the industry committee office he grabbed a telephone and wherever he smelled crude, he went after it. If he couldn't get it on the phone, he went to see the producer in the field or to the pipeliner or refiner in his office. Ten refiners in Dist. 2, he told them, had an inadequate supply of crude and the Army, the Navy and the Air Corps were demanding more and more products with which to fight the Germans and Japs.

Voluntary contributions of crude began coming in, but the total was never enough and is not today although crude runs to stills in the 15 Middle Western states totaled 1,240,000 b/d for the week ending Aug. 19—a new high. Total refinery capacity is placed at 1,325,000 b/d.

While "Curly" was acquiring his nickname, he went to grade and high school in Martinsville, Ill., then became a bookkeeper in the accounting department of Ohio Oil Co. at Robinson on May 18, 1926. He moved up to assistant cashier and in the fall of 1935 he was transferred to the company's headquarters in Findlay, O., as a member of the refining and marketing staff. He was an observer for Ohio Oil at the Madison oil trial.

In the autumn of 1938, he moved to Fort Worth, Texas, as southwestern sales manager for the wholesale department. That lasted for a little over four years and he returned to Robinson when the company's refinery at Fort Worth was sold to Premier Oil & Refining Co.

Outgrowth of Mr. Weger's wartime crude oil hunting activities was formation of the Dist. 2 crude oil supply panel, a subcommittee of the refining committee, on March 12, 1943. This panel was later elevated to the status of crude oil supply subcommittee of the general committee, Dist. 2, with Mr. Weger serving as vice chairman from the beginning. He joins Chairman Reid Brazell and subcommittee members in declaring: "It was a spirit of co-operation from the industry that made the panel and now the subcommittee's work a success."

"I didn't do a darn thing but go see 'em!" "Curly" said in an aside, referring to the producers, refiners and pipeliners.

He is married to the former Miss Irene Gregg of Martinsville, O., and she is keeping the home fire burning at Robinson while he battles on the oil front until his boss O. D. Donnell, president of Ohio Oil Co. and chairman of Dist. 2 general committee, has another assignment. Mr. Donnell told us that special assignments were Mr. Weger's forte and that he has never yet given him one that was not executed with efficient dispatch.

With Warren C. Platt in England

Maintaining Fire Protection for POL Depots in the United Kingdom

Necessity of Concentrating Huge Oil Suppliers Near Scene of Operations Presented Prevention Problem

By Lt. Col. S. J. Warner, Jr.

It is axiomatic that petroleum products are the lifeblood of modern warfare. Without an adequate, readily accessible supply of such products, action virtually ceases. The supply of these petroleum products to the United Kingdom was extremely critical in 1941-42.

It was obvious from the beginning that to successfully carry out the forthcoming military operations, huge supplies of petroleum products would have to be stored in locations readily accessible to military units. Geographical concentration of United States Forces, and general war strategy dictated that the majority of troop units would be stationed in Southern England. Accordingly, the majority of petrol and oil dumps were planned for the Southern Base Section division of ETOUSA. The fact that these sites would be definitely more vulnerable to enemy attack was realized, but military exigencies dictated that this risk must be accepted.

The Problem

It is not intended to discuss the mechanics or tactics of combatting petrol or oil fires, but simply to outline the problem of applying these principles to the situation encountered in this theater. The problem first came under discussion on the activation of Southern Base Section in the late summer of 1942. At this time, accurate plans had not been crystallized, and tentative fire protection planning was uncertain at best. However, as the situation developed in the fall of 1942, close liaison was established between the POL officer, Lt. Col. S. J. Warner, Jr., Headquarters, Services of Supply (Subsequently P.O.L. Officer, Headquarters, Southern Base Section), and Maj. D. N. Sutherland, Engineer Fire Adviser, Southern Base Section. Accurate planning was initiated and analysis of the situation was made. The problem of fire protection was found to be inextricably involved with other than fire problems. The problems together can be more readily appreciated by considering them under the following headings:

Siting of the Depots

Eleven static sites were decided on by higher authority with a tonnage capacity of 175,000 long tons or approximately 8,000,000 5 gal. Ameri-cans. Some of these sites had been occupied by British Forces as P.O.L. Dumps. The siting was found to be, in the majority of cases, undesirable from a fire-protection viewpoint. Sites were found to be located adjacent to heavily trafficked railroad lines and spurs, with the ever-present danger of flying sparks. Other sites were in close proximity to the Southern coastline with little or no natural or artificial concealment, thus making these sites extremely vulnerable to enemy attack. Still other sites were located at considerable distances from Civil Defense agencies, making the problem of supplying adequate support measures in the event of an emergency very difficult.

No remedial measures to correct these conditions could be initiated, since factors such as accessibility to road and rail networks and the availability of ground had decided the original siting. Discussing location, it might be noted that fire defense plans were predicated on adequate provisions of static water supplies based on a scale five gallons of water per ton of petrol stored. Municipal water supplies were not considered, since under emergency conditions it had been found that city or town water supplies were totally unreliable. The correct siting of this static water was of the utmost importance. Obviously, the supplies had to be far enough from the bases of the storage stacks of cans and barrels to enable the firemen to work efficiently and yet near enough that water relaying would be cut to a minimum. The tanks were from 10,000 to 25,000 gallon capacity, constructed below ground level with concrete or puddled clay linings. By the early part of 1943 the majority of the sites were under construction.

Unfortunately, due to the haste with which the sites had to be prepared, the limitations of the terrain and other factors beyond immediate control, the static water tanks were frequently poorly situated. Tanks were in some cases located immediately between can storage stacks, sometimes at too great a distance from the stacks. When natural water courses were depended on, they were not always sufficiently improved to permit fire apparatus to work satisfactorily. However, the time factor intervened, which, with the ever-present shortage of labor and material, prevented consistent construction of the ideal facilities.

Warren C. Platt, NPN's editor and publisher now in England reporting the story of oil and oil men at the front, asked Lieut. Col. S. J. Warner, Jr. to write the accompanying article on fire protection for the army's big oil depots in England. Col. Warner, formerly manager of Ethyl Gasoline Corp., in Tennessee, joined the army in 1941 and for a time was field technical supervisor in the quartermaster corps working out of Atlanta, building and operating oil supply depots.

Col. Warner was sent to England in 1942 where he continued building and operating depots.

Construction: The typical POL layout consisted of a varying number of stacks or bases 56 ft. square, with an estimated tonnage capacity of 260 tons net or 365 tons gross per base. Gravel road networks were built to enable the bases to be loaded and off-loaded. In addition, standard Romney huts were used for the storage of oils and greases. A diagrammatic layout of a typical POL depot is shown in the accompanying chart. As a result of the construction policy, a great many of the constructional safety features normally found in U. S. civilian bulk plants had to be omitted. Most prominent was the elimination of the so-called bounds or dykes. This policy substantially meant that in a fire there would be no barrier to the flow of burning petrol from one section of the depot to the other—a serious factor to a person who has seen a petrol dump on fire. Other constructional deficiencies included lack of alternate exits from the Romney hut and unsatisfactory access roads to static tanks from which the fire apparatus could work. But, at all times, speed and the utmost economy of labor and materials were the governing factors.

Fire Protection Measures

Equipment: It was decided that British fire equipment would have to be used in the depots because of the critical shortage of American equipment and, fortunately, the British equipment was found to be more suitable for the situation. This equipment consisted of "Medium" trailer fire pumps, capacity 500 GPM, complete with two foam making branch pipes (Mark II) and liquid foam compound. Also 34-gallon foam fire extinguishers, 2 gallon Foam fire extinguishers (equivalent to 2½ gallon U. S.), 1 qt. C.T.C. pump type fire extinguishers and buckets of sand were supplied through British and U. S. supply channels on recommendation of the District Engineer Fire Adviser. A normal scale of this equipment will be found listed in the diagrammatic layout (Fig. 1). Some considerable difficulty was encountered in effecting delivery of this equipment. Depots were activated frequently without notice and normal delays resulting from supply channels left depots unprotected for short periods of time. Also issuing agencies at the

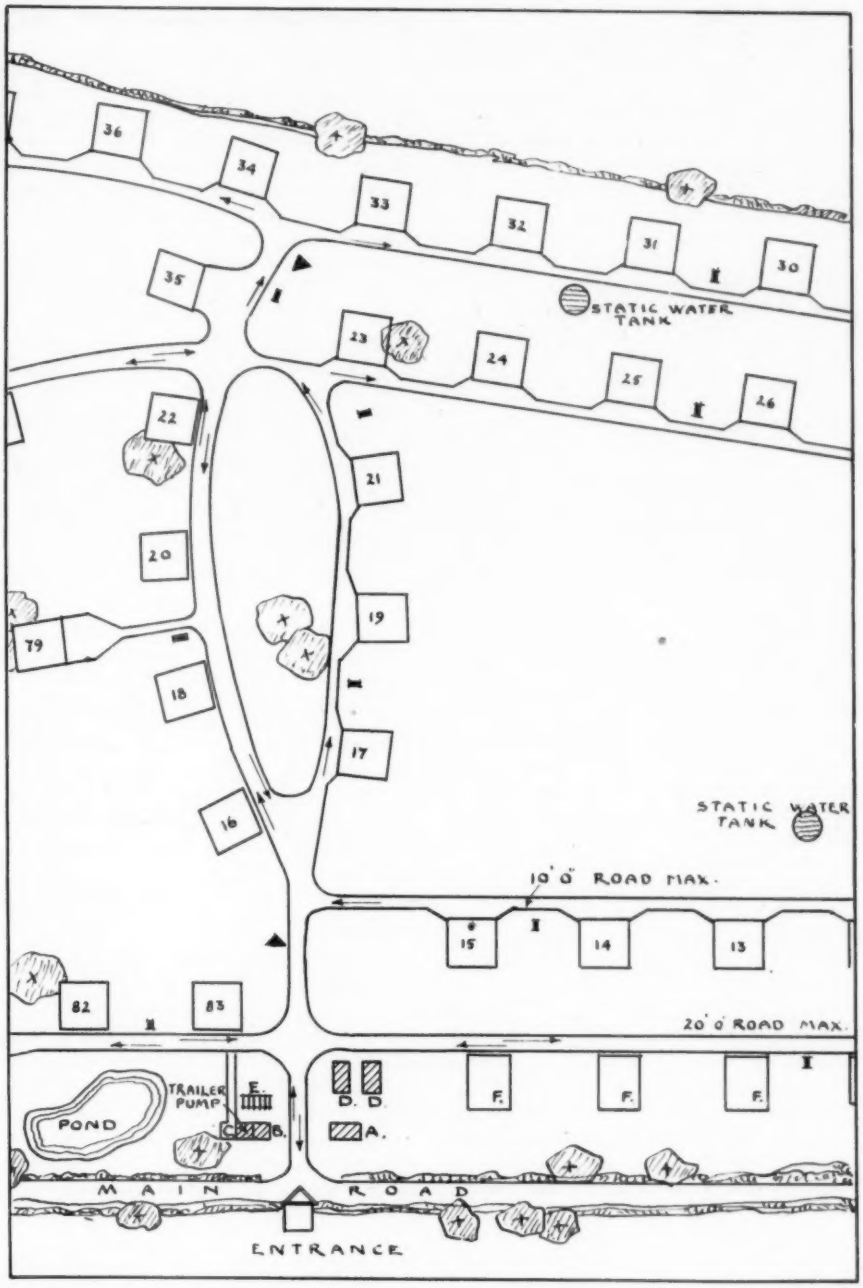
supply depots, being to a large extent unfamiliar with the British fire equipment, frequently delivered the wrong items. Two typical examples are a depot which received nozzles for a gasoline dispensing pump instead of nozzles for fire hose and the depot which received suction hose 4" for a water purification outfit instead of suction hose to fit the British trailer pump.

Firefighting Personnel: Although Engineer Fire Fighting Platoons (strength 1 officer, 28 enlisted men) were destined to arrive in this theater, they did not arrive until the late summer of 1943, and then not in sufficient numbers to have a material effect on the P.O.L. fire protection problem. Static depot personnel had to serve as the firefighting units in addition to their other duties. This was far from satisfactory. Due to the constant fluctuation of troop units, it was extremely difficult to maintain adequately trained crews. It might be noted that the successful combatting of petrol and oil fires requires a higher degree of technical skill than probably any other type of firefighting.

Normal Safety Measures: Due to the rapid influx of petrol and oil supplies in 1943, it was decided that normal safety distances would have to be reduced to provide more stacking area. This normal interval was 100 ft. The execution of the additional storage policy resulted in Diesel fuel in 55-gallon drums being stored between stacks; stacks being set up within a few feet of railroad tracks; and stacks being set up in fields adjacent to the depots at too great a distance to efficiently combat a fire with the depot fire equipment. Due to the urgency of the Depot operations, particularly during the initial stages of the North African campaign and the main mounting operation from the Southern Base Section, it was frequently necessary to violate practically all the usual commercial safety precautions.

Remedial Measures Taken: It was realized at once that emphasis would have to be placed on fire prevention education. Working on the adage that every large fire was once a small one, every effort was made to make all personnel in any way connected with the depots, "fire conscious". As many of the deficiencies enumerated were corrected insofar as possible, but overcoming normal antipathy to fire prevention work was the greatest problem. The more important phases of this work are as follows:

Constructional Deficiencies: Responsible constructional agencies were contacted as early as January, 1942, and where the construction was not completed, every effort was made to have deficiencies corrected. Excellent cooperation was received, once the importance of fire prevention was explained. Constructional directives were changed and the Depots constructed in the summer and fall of 1943 were far superior from a fire prevention viewpoint to those constructed in the initial phases.



The thoroughness used by the army in England for protection of oil is shown by this section layout of a typical oil depot. The squares show location of can and drum stacks. The black pyramids represent fire gongs. The small black squares indicate location of 30-34 gal. foam extinguishers. Cross-hatched circles indicate static water tanks. The cross hatched irregular areas with small crosses in center are shrubs or little hillocks to be removed. In foreground are: "A" guard room; "C", trailer pump house. Four sand buckets and four two-gallon foam extinguishers are located at each stack. No lighting is used except in office and guard house

Training of Personnel: Perhaps the greatest emphasis of all was placed on this subject. It can be broken down under two headings:

General Training Measures: All depot personnel, including officers, were trained in the maintenance and operation of all fire equipment on hand. This training continued throughout the life of each depot because of the troop fluctuation. Personnel were impressed with the importance of observing "No Smoking" rules and other safety precautions and also with the vital importance of immediately summoning assistance from the National Fire Service in the event of a fire, regardless of the extent of the fire. Observance of this last precaution proved its value on several occasions when fires which might have gotten out of control of the Depot personnel were efficiently extinguished by the prompt

arrival of the National Fire Service.

Demonstrations: Firefighting and fire prevention demonstrations were conducted at all POL depots at frequent intervals, since it was realized in the initial phases of this work that physical and visual experience of the effect of burning petrol or oil was far more effective than any directive which might be written. These demonstrations were conducted by the British Army Fire Service, the National Fire Service and the Engineer Fire Fighting Platoons, U. S. Army. Depot personnel physically participated in all demonstrations. Two particular demonstrations to observe the effect of heat on the various types of petrol and oil containers were conducted. The results obtained from these two demonstrations were invaluable in determining the time element within which it could reasonably be expected a burning petrol stack could be successfully combatted, and also the effect and efficiency of the various types of fire equipment. Actual stacks of petrol were used during these exercises. The effects of incendiary bombs and normal sources of ignition were noted with great care. These two particular demonstrations were intended primarily for officer personnel in order that responsible officers would know what tactics or procedure to follow if confronted with a fire emergency. Officers were impressed with the importance of acting coolly and efficiently and with the fact that with efficient action one or two stacks might be lost in a fire, but the majority of the stacks could be saved. Three photographs illustrate these demonstrations.

Support Measures: In the time of crisis prior to 1939, when war in Europe seemed inevitable, the Auxiliary Fire Service was formed in the U. K. to augment the Municipal Fire Brigades which, obviously, while adequate for peacetime purposes, would be unable alone to cope with the additional fires caused by enemy action. The personnel of the Auxiliary Fire Service was composed of men and women from all walks of life, some of whom gave up their normal occupations to do this important work, others did their usual day's work and then spent their leisure time doing clerical and other duties at the Fire Stations.

Subsequently the Municipal Fire Brigades and the Auxiliary Fire Service were merged and became the National Fire Service. Their tactics, drills, equipment and general procedures are standardized throughout the U. K. and this has proved invaluable on those occasions when it has been necessary to bring additional personnel and equipment to the Southern Counties from other parts of the U. K. It was realized that in an emergency, due to enemy attack or due to a normal "lull" period fire, depot fire fighting personnel could at best act as a "first line" defense. Additional

American Alphabet Terms Confuse the British

LONDON—The designation "SAE" on American lube oil grades and denoting that well-known technical society, the Society of Automobile Engineers, has caused confusion among United Kingdom employes in this war effort because it happens to respond to a time-respected term in the British War Department: "Small Arms Equipment". But one war office clerk marked it out as "Standard American Equivalent."

One cannot blame the average man in the street, because one of the great hardships of this war is the infliction of so many hundreds of initial designations on the minds of good citizens who just want to win the war and not respond to memory tests. Both army and navy and the British give you another and very heavy dose of initials over here when you had fled them back home.

° ° °

Back home, the U.S. oil industry thanks to the American Petroleum Institute, has practically standardized the 42-gal. wine barrel, for crude oil. However, one oil man recently complained that when you talked to some officials of a certain large company they still figured in the old 50-gal. refining and marketing barrel.

Meantime, casual visitors to these ocean-minded parts wonder if there can't be a standardization on barrels instead of tons. All talk here, in all forces, seems to be of "tons of oil" and for a landsman to get his bearings, he must translate it into barrels or gallons which calls for mental arithmetic and generally results in errors, especially as common practice is to use 10 bbls. to the ton and let the fractions take care of themselves.

The shipping boys have to use tons when they fill tankers or when they put barrels into cargo ships, but, question the newcomers, why can't they use barrels right up to the point where their clerks have to write out manifests and then let the clerks fuss with conversion to tons?

° ° °

Oil as a fuel, both industrial and domestic, has been steadily making inroads in British coal markets, just as it has in the U.S. Now papers report the construction of new coal-carrying ships that will burn oil. Not only will this liquid fuel contribute to the comfort of the men, it is pointed out, but the ships will be fitted out with more comfortable quarters for them than has been customary on colliers.—*W. C. P.*

The fire extinguisher foam piled up after an oil can fire in a POL depot in England looks a bit messy. But it saved the precious oil for the smooth running of American invasion forces

Here is a foam extinguisher in action at an oil depot in England. Fire in this bunch of oil cans was quickly extinguished. Foam type extinguishers are found wherever cans are stored

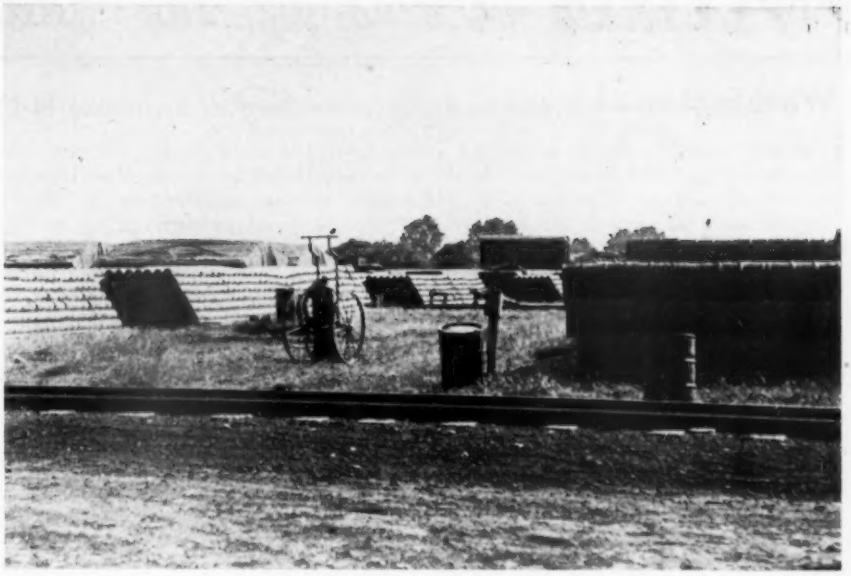
assistance would have to be provided without delay. Fire Orders in all Depots required that the nearest N.F.S. brigade must be summoned at once regardless of the extent of the fire and without reference to any particular individual, as previously stated. This premise was emphasized in the training programs.

Contact was made with the key N.F.S. personnel in each so-called Fire Force Area by the Base Section Engineer Fire Adviser. Arrangements were made to have the maximum number of fire appliances make the "first run" attendance. Emergency supplies of foam making compound and foam making equipment were provided at each N.F.S. station nearest to the P.O.L. Depot. Periodic inspections of the Depots by N.F.S. fire prevention officers were arranged. Fire demonstrations were conducted. In brief, every possible assistance was given by the N.F.S. in the carrying out of the fire prevention program.

General

The same general fire prevention program as outlined above was carried out during the mounting operation for the invasion of Normandy on D-Day. Four operational dumps containing a minimum stock load of 1,600,000 gallons each were established on the south coast. The fire defense plans were of necessity much more flexible, due to the rapid changes in the situation, however, the same general principles were followed. Static fire crews from the N.F.S. and Engineer Firefighting crews were stationed at all P.O.L. dumps or depots considered to be most vulnerable to enemy attack. At the two most critical depots 6" static water lines were laid from the nearest natural supply. Stationary pumps were placed at these unlimited natural supplies, thus insuring adequate water supplies in an emergency.

In conclusion, it might be stated that in a theater of operations, fire prevention measures as practiced in the United States are in the main hard to accomplish. Accurate planning is extremely difficult, due to security regulations and the fact that the situation is constantly changing as the war strategy develops. The urgency of ascomplishing certain missions within specified times precludes the possibility of complying with normal safety regulations. Responsible officers or N.C.O.'s must apply themselves assiduously to the accomplishment of their fire prevention programs. The situation must be constantly checked, and responsible N.F.S. agencies kept informed. Fire defense plans should be flexible and capable of rapid readjustment. Improvised methods of improving fire protection must be constantly used. It should be realized that due to emergency conditions the ideal fire protection measures will never be realized but that efforts should never be relaxed in the attempt to achieve that goal. The results of the fire prevention program as applied to U. S. army POL installations in the U.K. have thus far been most successful, and to date, no fire has developed in any of the depots other than grass fires which were controlled without difficulty.



The 30-34 gallon foam extinguisher shown in foreground at this POL depot in England is one of many placed at regulation stations throughout the depot. Covered with tarpaulins in the back are hundreds of "Ameri-cans", so called to distinguish them from the German or British type. At the left are stacks of 5 gallon lube oil cans

No Gasoline, Everyone in England, Rides a Bicycle

A fair percentage of our English allies are on bicycles these days. They all ride them, old and young, women and children. Parcels are piled high on handle bars, or held in baskets and special containers fore and aft and even on the side. One gentleman had a full-sized suit case fastened to the side of the rear wheel as he pedaled with one bowing leg down the road this morning.

Distances are not far and roads and streets are good but there is no gasoline for anyone who cannot prove pretty definitely that he is going to use most every drop of it in the war effort. From the number of bicycles on roads and streets, it would seem there isn't any fooling about gasoline rationing.

However, it is a good bet that the bicycles will disappear as gasoline brings old cars out of garages and puts new cars on the roads. We are inclined to put up our noses at the small cars, especially of the Austin variety, but after riding in both good small English cars and a full-sized quality American car, used by the army, I must say the small car rides easily, handles well and, if one does not want to get up to 75 or 85 miles an hour on some straight-aways, which are rare here, one is just as comfortable and saves money in the smaller cars.

Perhaps back home our tendency to smaller and lighter cars will continue and perhaps the soldiers will bring back some preference for them. I'll confess that views I have had for years, until they became prejudices, have pretty well vanished.

If experience with English light cars helps further this point of view, then when the soldiers all get back and our "new" cars of "the future" appear, maybe the oil industry will have to refigure its volumes per service station and its volumes per truck and bulk plant and get down to new and lower cost levels. —W. C. P.

'Directives' Draw Fire of An English Judge

LONDON—They have "directives" in England but it seems they have to be submitted to parliament for approval before they are legal. The other day a local judge refused to take the word of a "bureaucrat" that a certain directive had been so submitted and asked for proof. It then appeared the due process of law had not been carried out so the judge threw the case out of court with harsh criticism. This last he repeated at some length in a Sunday paper following.

A bill was promptly introduced to legalize all directives that had thus been

(*Continued on p.* 56)

PIPELINES—*Views of the Industry's Problems a*

Washington— *Marshall Departure Seen as Beginning of End of PAW* —By Herbert Yocom

WASHINGTON—Much as his loss to the oil agency is to be regretted, the departure of J. Howard Marshall as PAW's chief counsel is being taken here as a sign of the beginning of the end of PAW, and, therefore, as the first definite indication that PAW Ickes intends doing exactly what he has said he will do and liquidate PAW as rapidly as conditions allow.

Mr. Yocom

To a degree, the conclusion seems to be justified. There is implied, at any rate, in the fact that Mr. Marshall is being allowed to depart at this juncture, a recognition on the part of Mr. Ickes that the day of new and drastic orders and directives from Washington is over and that about all that remains to be done now—subject always, of course, to changing war needs—is to modify, relax and repeal.

* * *

After slipping through the Senate with little or no notice, the Ickes "land grab" portion of the surplus property disposal bill is now one of the bitterest points of dispute before a joint House-Senate conference committee which is attempting to reconcile conflicting congressional approaches to this hottest of postwar problems.

Senators who, in the beginning, apparently were not aware of just what the Senate bill contained, have now had those sections pertaining to the disposal of surplus real property called to their attention and are working on the Senate members of the conference group to obtain elimination of some of the most objectionable features. In particular, they are centering their attention on that section which would allow the Secretary of the Interior to reserve in the federal government the rights to all oil, gas and mineral deposits in land which is sold to other than the original owners of the property.

So far as the conferees for the House are concerned, they are reported to be in complete opposition to the real property provisions of the Senate bill. This points to the possibility of a deadlock in committee, in which event the conflict will be thrown onto the floor of both houses for final settlement.

* * *

Office of Defense Transportation has quietly called off its proposed experiment into the use of wooden barges for hauling of crude on the Mississippi between New Orleans and Wood River, Ill.

Two reasons are given for the cancellation: First, a lack of crude, and, second, a general improvement in the overall transportation picture which is said to rule out the need for using the barges on the Mississippi.

If plans had gone through, a tow of 12 barges was to have been dispatched upstream towards the end of this month for the purpose of determining just how the wooden craft would perform. Had the experiment turned out successfully, the idea then was to establish a regular service, employing some 70-odd barges.

* * *

The following is quoted from the Bureau of Mines section of an announcement by Secretary Ickes in which he states that "more than 1,500,000 of our fighting men, as they head home from Berlin and Tokyo, can find at least a year's employment on postwar projects already tentatively outlined for congressional approval by the Department of the Interior:

"Recognizing that the war has taken the "cream" of much of America's irreplaceable mineral wealth, the Bureau of Mines expects to send research workers, engineers, chemists, and other scientific men into every section of the nation to chart the untouched reserves of coal, oil shale, oil-bearing sands, zinc, lead, iron, chromium, tungsten, magnesium, and dozens of other metals.

"Calling for an outlay of about $11,000,000 in planning costs, the bureau's postwar program, if Congress provides the funds, also will involve expenditures of nearly $157,000,000 for laboratories and other research projects. Stemming from this investment by Uncle Sam will be an estimated billion-dollar outlay in increased capital investments by industry as new enterprises and plants are created.

"In terms of employment to returning service men and women and to war workers, the program will spell ultimately nearly 600,000 man-years of employment, public and private."

Atlantic Coast—*U. S. Firms May Abandon European Refinery Investment* —By Frank P. S. Glassey

NEW YORK—American oil companies are seriously considering abandoning a $250,000,000 refinery investment in Europe, and shipping refined products instead of crude to the Continent after the war.

Mr. Glassey

The ultimate decision will probably depend on the degree of nationalism existing in reconstituted European nations, as reflected in postwar tariff barriers on petroleum products. The best opinion at the moment inclines to the view that major American companies will be forced to return as refinery operators, but the entire subject is being thrashed out at a series of informal conferences here and in Washington.

Several advisory committees, consisting of executives of companies which had a huge prewar European business, and appointed by PAW, have been mulling over the pros and cons of the question of rebuilding foreign refineries in Europe. These groups operate under Directive 70, and their deliberations are attended by government observers. An air of some secrecy has surrounded the whole discussion, whose final outcome will probably not be decided for many months after Germany's collapse.

It's generally agreed here that, from a purely economic viewpoint, the refinery business in Europe was unsound, and developed from over-zealous nationalism. Construction materials, except in the cases of Germany and Sweden, had to be imported, chiefly from the United States. Technical development and operation were in the hands of foreigners, mostly Americans. The number of men employed was small, considering the capital investment and refinery throughput.

The era of European refinery construction was inaugurated by France in the late nineteen-twenties, with Italy and Germany following the example of their western neighbor. The big refinery areas in France are west of Marseilles to the Spanish border, along the Seine from Le Havre to Rouen, at Gironne near Bordeaux, in Alsace, Lorraine and at the mouth of the Loire. Most of the French refineries have either been destroyed or removed deep into the interior of Germany. Many were destroyed by American employes under the direction of British and French military authorities during the debacle of 1940.

The Italian refineries have probably been well bombed. They were located principally in Fiume, Trieste, Naples, Venice and on the southern tip of the peninsula. Prewar German refineries, also the object of concentrated attention by Allied airmen, were chiefly at Bremen, in the Hamburg area and at Hannover.

The Rumanian refineries, now in Russian hands, fall into a different category. Situated near the source of crude supply, they will undoubtedly be rebuilt when construction materials are available.

Leading foreign operators of conti-

nental refineries were Standard Oil Co. (N. J.), Socony-Vacuum, The Texas Co., the Shell group and Anglo-Iranian. One fairly reliable estimate is that total refinery investment in Europe before the war was $400,000,000 of which 60 per cent was American capital and the other 40 per cent British and native. Most of the American companies have long ago written off their European properties as a complete loss.

Those who argue that the United States should remain out of the refinery picture in Europe after this war contend that it would be more economical for Europe to import finished products from the United States, the Caribbean and the Near East. Russia is still an unknown quantity, with no indication whether the Soviet Union will have a surplus after meeting its own rehabilitation needs.

The contrary view is held by some former owners and operators of continental refineries, who believe that European nations after the war will be just as nationalistic as they were in the twenties and thirties, and will keep tariffs on refined products so high that the American companies' only solution will be to ship crude to Europe and refine it there. This belief is supported by three contentions:

1. Foreign exchange will be scarce after the war. It will require less exchange to import crude than products.

2. European nations will be interested in building up their own industries, and they realize that profits go to the country making the finished product.

3. Oil has always been considered a vital commodity, both in peace and for national defense, and the nations of Europe will not want it in the hands of foreigners. Furthermore, where you have the indigenous product—as in Germany, Hungary and Rumania—refineries are justified.

Another oil man described the outlook this way:

"European governments after the war will say, 'If there is anything to the Atlantic Charter, everybody should be given a fair chance to get raw materials. Why shouldn't we obtain cheap crude and have refineries within our own borders?' That question will be hard to answer."

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The East Coast problem of how to obtain enough blended fuel oil this winter has eased considerably in the last few weeks because of the prospect of substantially more high-grade No. 2 heating oil. In fact, the East Coast's stocks on hand of all products except gasoline are above a year ago.

Meanwhile PAW has asked refineries if they cannot increase kerosine production this fall. PAW is also considering sending men to various areas in Dist. 1 to check on quality of fuel oil stocks. In areas where there is much catalytic product, the higher-grade No. 2 may be poured in large quantities.

Midwest— *Vandeveer Good Timber for World Oil Commission* —By Earl Lamm

CHICAGO—The call has gone out for able men of unquestionable ability and integrity to serve on the International Oil Commission which would be set up to function under the Anglo-American oil agreement of Aug. 8. Word is that success of the Commission and the hope of achieving any worth-while purpose along constructive lines, like all such things depends upon industry and public approval, acceptance and respect for the men serving on the Commission, when and if the Commission itself is given Congressional sanction.

Mr. Lamm

J. Howard Pew, president of the Sun Oil Co., in his letter of Aug. 17 to Senator Connally clearly set forth some of the pitfalls to be avoided if the Commission receives the green light.

One man who we confidently believe would devote great effort and all his marked ability in sidestepping those snares is W. W. Vandeveer, PAW director in charge of Dist. 2, provided he could be persuaded to serve.

Whether Mr. Vandeveer would serve, we don't know. We have not asked him, but there are many excellent reasons for suggesting his name.

The industry at large would undoubtedly be greatly affected by any action the Commission might take, and its membership should be largely composed of men with the experience and "know how" of producing, transporting, refining and distributing petroleum and its products. Mr. Vandeveer has that experience, plus over a year of government agency management, after which he received the hearty indorsement of the industry in the Midwest — both independents and majors—who know him best.

But joining PAW did not initiate him into the co-operative industry-government war oil effort. He was active from the beginning as chairman of the Dist. 2 tanker transportation subcommittee; was chairman of the transportation subcommittee on the joint use of petroleum facilities in Dist. 2; a member of the Dist. 2 supply and distribution committee and a member of OPA's fuel oil industry advisory council.

He is president on leave of Allied Oil Co., Inc., of Cleveland, O., and could afford the luxury of service on the Commission, while his partner, F. R. Newman, and associates continue operation of their private business. If complete severance from private business is a Commission membership requisite—only Mr. Vandeveer could answer that. Allied subsidiary companies owned by Mr. Vandeveer and Mr. Newman are Canton Refining Co. with a plant at Canton, O.; Cleveland Tankers, Inc. operating four tankers on the Great Lakes in addition to barges and other equipment; Central Pipeline Co. which buys crude in Illinois and East Texas.

Last but not least, at 57 Mr. Vandeveer is possessed of vigor and a Dutch temper that lets the chips fall where they may when he states his opinion.

However, there is another very excellent reason for nominating Mr. Vandeveer for the Commission assignment, well outside the realm of personalities. It is contrary to the New Deal ideological declaration of scarcity of all things.

Well-founded opinion in the industry has marked the Midwest as the future dumping ground of everything from raw crude oil to refined products, and it is hoped that this can be avoided if this large area has an active representative in an organizational set-up such as the International Oil Commission is hopefully supposed to be.

In the early postwar period, with military demand for products gone, it is anticipated by many oil men high in the industry that the four private pipelines from the East Coast which were reversed to serve the needs of war, will again be reversed and start pumping petroleum into the Midwest market. Add to this the possibility that a fifth new pipeline will do the same thing, plus the further possibility that the Big Inch and Little Big Inch pipeline flows will be chopped in two at the Norris City, Ill., junction point, and petroleum from both the east and west ends starts adding its flow to the general dump.

The idea is not new, and once the war is over, the Midwest has no fear of a scarcity of petroleum and its products but trembles at the load it will be expected to carry when the nation's greatly enlarged private and U. S. Maritime Commission's tanker fleet starts transporting petroleum for civilian consumption. Some of it may come from Arabia and the Middle East and be poured into the eastern legs of the two Big Inch pipelines.

Large new refineries are also being built in the Caribbean and South American areas. And at least for some time, Europe will have no automobiles and the U. S. will be operating on a greatly reduced number of old ones.

Naturals' Spellout Drafted for Industry Study; Chief Emphasis Placed on Shipments to East

NPN News Bureau

WASHINGTON—OPA and the industry this week took up the problem of spelling out specific dollars-and-cents ceiling prices on natural gasoline of Reid vapor pressures of from 12 to 26 lbs., on both an F.O.B. and a delivered-at-destination basis, with particular emphasis on shipments moving to the East Coast.

At a meeting here Aug. 29, representatives of the principal natural gasoline producers and sellers examined specific prices proposed by the price agency. Industry members returned home with a schedule of prices, which since then has been slightly changed. Present schedule, which will be circulated to the industry by OPA, appears below.

Reason for the OPA-industry study of the natural gasoline price problem which has culminated in the tentative spell-out is, of course, obvious: Before the war, the industry employed either Breckenridge or Group 3 as a basing point for all shipments of natural gasoline. The Breckenridge basis was usually used for shipments from North Texas to the Texas Gulf Coast where the product was either placed in storage or else loaded in tankers for shipment to the East Coast. On the other hand, Group 3 was used for shipments from Oklahoma moving north and east into the Mid-lle West.

Problem Long Under Study

But tankers have not been available at the Gulf for coastwise movement of naturals for the past two years, and since the product has had to be shipped by tank car to Dist. 1, OPA has thought it advisable to spell out specific prices to cover these shipments.

OPA officials have recognized for some time the necessity of setting specific prices but have not tackled the job until other major price spell-outs were set up on products which, in contrast to naturals prices, have bucked the ceiling and thus rated first attention. The prices proposed by OPA, officials say, are pretty well in line with those being charged by the industry.

Although main topic of discussion at the meeting concerned establishment of specific prices on naturals moving into the Atlantic Seaboard area, the closely-related problem of spelling out a formula for computing delivered-at-destination ceilings on naturals moving to points in Dist. 2, 3 and 4 was also taken up. Industry members and OPA were reported in agreement that the same sort of solution should be applied as was formalized on gasoline and kerosine in 11 Midwestern states by amendment 15 to MPR 88.

Proposed Formula Explained

This has since been studied by OPA and it is presently anticipated that a formula will be set up and wrapped in with the spell-out on eastward movements so that both actions issue in one package. At the present time, it is expected that the following formula will be laid out for determining delivered-at-destination ceiling prices in Dist. 2, 3 and 4: F.O.B. refinery price at Breckenridge as specified in table above plus Oct. 1, 1941, rail rate to destination, or Oklahoma F.O.B. refinery price as set out in above table plus Oct. 1, 1941, rail rate to destination, whichever is lower.

This formula can be expected to apply uniformly to all buyers and all sellers, as compared with the delivered-at-destination spell-out on gasoline and kerosine in the Mid-west which set up different formulae for different classes of purchasers and sellers. Another distinction, it is expected, will be the absence of any reference to resellers' margins as in amendment 15, inasmuch as naturals are handled by tank car and not by tank wagon.

Price on Stored Product

One other point taken up at the meeting was the question of allowing suppliers a markup when the product is moved to the Gulf Coast, stored in supplier's tanks and delivered some time later to the buyer. Indications are that OPA will allow such suppliers to compute prices as follows: F.O.B. refinery price at Breckenridge plus Oct. 1, 1941, rail rate to storage point along Texas and Louisiana Gulf Coast, plus 0.25c per gal. This, in effect, would set up a delivered price on such transactions.

One other angle which has not yet been definitely decided involves markup to be allowed brokers of natural. The schedule above on movements to Dist. 1 will apply to all sellers, but it is expected that when computing delivered prices at Dist. 2, 3 and 4 destinations, an "eligible marketer" will be allowed to add 0.125c per gal., to the price resulting from formula which OPA now contemplates establishing, that is, Breckenridge or Oklahoma F.O.B. refinery price as set forth in table plus Oct. 1, 1941 rail rate, whichever is lower.

Proposed Natural Gasoline Prices—Shipments To District One

(cents per gal.)

	RVP Lbs. Sq. in. at 100°F.	Breckenridge Texas Area	State of Oklahoma	State of Kansas	Central Illinois	N. Tex., W. Tex., State of New Mexico	E. Tex. N. La. S. Ark.	Texas Panhandle
100%	26	4.50	4.75	4.88	6.00	4.50	5.16	4.59
105%	24	4.72	4.99	5.12	6.24	4.72	5.38	4.83
110%	22	4.95	5.22	5.35	6.47	4.95	5.61	5.06
115%	20	5.17	5.46	5.59	6.71	5.17	5.83	5.30
120%	18	5.40	5.70	5.83	6.95	5.40	6.06	5.54
125%	16	5.62	5.94	6.07	7.19	5.62	6.28	5.78
136%	14	6.12	6.46	6.59	7.71	6.12	6.78	6.30
145%	12	6.52	6.89	7.02	8.14	6.52	7.18	6.73

WAR OIL NEWS from WASHINGTON

HERBERT YOCOM *Bureau Chief*
NATIONAL PRESS BLDG.
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Phillips Leaves OPA; McCullough Succeeds

NPN News Bureau

WASHINGTON—Charles F. Phillips, OPA deputy in charge of rationing, left his government post this week to take up duties as president of Bates College on Sept. 1 and was succeeded by Maxwell L. McCullough who has served as OPA regional administrator in Dallas, Tex., since January, 1942.

Mr. McCullough is 40 years old, married, and has three children. A native of Texas, he studied at Buford Business College, Dallas; Baylor University, Waco, Tex.; Columbia University, New York City; and the University of Paris.

Prior to joining OPA, he was director of public welfare and assistant finance director of the city of Dallas. Before that he served the county of Dallas as secretary of the Commissioner's Court and as Budget Officer. Before entering public life, he was buyer and assistant manager of the McCullough Department Store at Mesquite, Texas.

Graduate of Colgate

With OPA since 1941, Mr. Phillips took a leading part in the development of OPA's first rationing program, that on tires, in December 1941 when he held the position of associate price executive of the rubber and rubber products section. He came to Washington from Syracuse, N. Y.

A graduate of Colgate University in 1931, Phillips received his Ph.D. from Harvard in 1933 and for a time was professor of economics at Colgate University, later serving as marketing consultant to a large food store chain. He became di-

rector of OPA's automotive products rationing division in June 1942, and succeeded Col. Bryan Houston as deputy rationing administrator in May of this year.

In announcing the selection of Mr. McCullough as Phillips' successor, OPA Chief Bowles said:

"Mr. McCullough brings to the national office a splendid record as administrator in the Southwest region, comprising the states of Texas, Oklahoma, Kansas, Missouri, Arkansas, and Louisiana. He has served continuously as regional administrator since the regional office was organized early in 1942. He has performed a difficult job extremely well. The national office is indeed fortunate to obtain the benefits of Mr. McCullough's experience in the field in administering the rationing programs.

"We are extremely sorry to lose the valued services of Mr. Phillips, who has played a major part since OPA began in the development and administration of our various rationing programs. It is with deep regret that we see him go.

"In selecting Mr. McCullough as his successor, we have chosen a man who has won the respect and admiration of his fellow administrators in the field, as well as the officials in the national office. I am sure that he will bring to Washington the kind of training, experience, and judgment necessary to administer the difficult job of rationing that lies ahead."

Hardwicke Becomes PAW's New Chief Counsel; Marshall Retires to Private Practice

NPN News Bureau

WASHINGTON — After more than three years on the job, J. Howard Marshall stepped down this week as PAW's Chief Counsel and was succeeded by Robert E. Hardwicke, prominent Texas oil lawyer.

As the top legal adviser to PAW Ickes and Deputy PAW Davies, Mr. Marshall laid the legal foundation for the cooperative government-industry war-oil program and figured prominently in the formulation of PAW operating policies.

He had been Chief Counsel since July 25, 1941, and an Assistant Deputy Administrator, as well, since September, 1943. After a rest, he will rejoin his old law firm—Pillsbury, Madison, and Sutro—in San Francisco.

Departure of Mr. Marshall was announced with "deep regret" by PAW Ickes, who said:

"As Chief Counsel and Assistant Deputy Administrator, he has made an especially outstanding contribution to the success of the Government's oil agency during the past three years of war emergency.

"Responding to my urgent request, Mr. Marshall joined the organization at the very beginning. Continuously since then he has applied his unique experience in law, in Government, and in the oil industry, to the creative problems of organizing and charting a course for PAW. Conscientiously, fairly, and impartially, he has discharged the responsibilities entrusted to him.

"Mr. Marshall remained well beyond the period originally contemplated in June of 1941 when he first came to Washington. He stayed on at great personal sacrifice for over three years and I wish personally to acknowledge my appreciation of the large contribution that he has made in public service during the war.

"The assignment with PAW represents the second time that Mr. Marshall, at my personal request, has entered the public service in time of crisis. He was a member of the Petroleum Administrative Board during the NRA period and helped to win the battles of 'hot oil'—a step forward in the conservation of our vital petroleum supplies for which, in the present emergency, we may indeed be grateful."

This was Mr. Marshall's second period

J. Howard Marshall

of service with the Federal Government. Following graduation from Yale and two years as assistant dean of Yale Law School, he was summoned to Washington in 1933 by Administrator Ickes to become assistant solicitor of the Interior Department and a member of the Petroleum Administrative Board.

During his stay in Washington, from 1933 to 1935, Mr. Marshall also served as a member of the Federal Tender Board for the East Texas Oil Field, special assistant to the U. S. Attorney General, and special representative of the Secretary of the Interior on the Board of the Pacific Coast Petroleum Agency and the Central Committee of California Oil Producers.

In 1935, he resigned to become the special legal and economic counsel of the Standard Oil Company of California, with headquarters in San Francisco. He remained with that company until 1937, when he resigned to become an associate attorney in firm of Pillsbury, Madison, and Sutro. Mr. Marshall became a partner in the firm in 1938.

OPA Promotes Keeton; Will Succeed Judd

Mr. Phelps

Mr. Keeton

NPN News Bureau

WASHINGTON — W. Page Keeton, Legal Counsel for OPA's Fuel Price Division since March, 1944, and Chief Counsel of the Petroleum Price Branch within the division since June, 1942, this week moved up as head of the Oil Price Branch, succeeding Orville D. Judd, recently appointed Associate Director of the Fuel Price Division, which comprises both the Petroleum Price Branch and the Solid Fuels Price Branch.

At the same time, OPA announced the appointment of Arthur W. Phelps as successor to Mr. Keeton in the post of Chief Counsel of the Petroleum Price Branch.

Mr. Keeton, 35, before coming to Washington, had lived virtually all his life in the heart of the principal oil producing area in the U. S. He was born and reared in Clarksville, Texas, later going to the University of Texas in Austin, where he was graduated in 1931.

For one year after leaving college he served as business manager of the Texas Law Review, a corporation publishing a legal journal, and in 1932 he was appointed Professor of Law at the University of Texas. In September, 1940, he was made Assistant Dean of the Faculty of Law. He obtained leave of absence from the university in order to go to OPA in June, 1942.

Studied Oil Exclusively

During his more than two years with OPA Mr. Keeton has devoted his time almost exclusively to oil matters, and thus has had an opportunity of becoming familiar with all phases of the industry. He is married and has two children.

Mr. Phelps, the new Chief Counsel of the Petroleum Price Branch, is 35 years of age. He was born in West-

moreland County, Virginia, and has received degrees from Washington Lee University, Ohio State University, University of Cincinnati and Columbia University. Before going to OPA in January, 1942, as Assistant to the Chief Price Attorney in the Cleveland Regional Office, he was Assistant Professor of Law at Ohio Northern University, Ada, Ohio. He transferred to OPA's National Office in August, 1943, becoming Senior Attorney in the Petroleum Price Branch. He is married and has one child. His home is in Arlington, Va.

PAW Appoints W. H. Newman Executive Officer

WASHINGTON—PAW this week announced the appointment of W. H. Newman as executive officer of the oil agency, replacing E. L. Kohler who has resigned. Mr. Newman will continue to direct the work of PAW's organization planning staff with full responsibility for review, determination and recommendation of changes in basic operations of PAW.

With a lengthy background of organizational planning and personnel work both in industry and several universities, Mr. Newman was appointed a chief consultant to OPA in March 1942. Four months later he transferred to WPB as organization consultant, where he remained until November 1943, when he joined PAW. He was appointed PAW's director of organization planning on May 8 of this year.

OPA Will Permit the Use Of Loose A-12 Coupons

NPN News Bureau

WASHINGTON — In a memo to gasoline dealers, OPA this week advised that an amendment to RO 5C is being issued that will make it legal for them to accept, and for motorists to offer, loose A-12 gasoline coupons resulting from special circumstances that may arise in the renewal of "A" coupons outside the East Coast.

Text of OPA's memo follows:

"Gasoline dealers outside the East Coast may be asked to accept a number of detached A-12 coupons during the next two weeks. Ration holders, who are required to submit back covers of their "A" books when applying for a renewal of their basic ration, may in some cases have to tear their only remaining coupons from the back part of the cover and thus have two or three perfectly legitimate coupons that are not attached to a cover.

"This circumstance makes it doubly important that service station operators and attendants be extremely careful to check the endorsement on all coupons. Previously, the dealer has had two ways to protect himself against receiving counterfeit coupons—to check the endorsement and to make sure that the coupon was attached to a cover. But until the A-12 expires on Sept. 21 (in all areas except the East Coast) he will have only one of these safeguards.

"An amendment to the ration order is being issued that will make it legal to offer and accept these detached coupons. However, we want to re-emphasize to all gasoline dealers:

"To protect yourself against counterfeit coupons, make sure that the license number and state of registration endorsed on every coupon corresponds with the license number of the car into which gasoline is delivered."

September Motor Fuel Demand Continues Heavy; Bureau Foresees All-Time Record for 1944

NPN News Bureau

WASHINGTON—A total motor fuel demand of 66,100,000 bbl. during September was forecast this week by the Bureau of Mines, compared with 68,200,000 bbl. forecast for August and 56,671,000 bbl. actually consumed during September a year ago.

At the same time, the bureau predicted that the total demand for motor fuel may exceed all previous records in 1944. During the first six months of the year, this demand was about 23 per cent greater than in the same period of 1943, compared with an increase in the combined total demand for residual and distillate fuel oils of about 15 per cent.

Total demand for all oils, bureau pointed out, rose from 1,420,000,000 bbl. in 1939 to 1,457,000,000 in 1940 and 1,595,000,000 bbl. in 1941, and if present trends continue for the remaining months of this year, total demand in 1944 may exceed the amount for 1941 by about 20 per cent.

Crude Output Up 14%

During the first six months of 1944, daily average crude production was 14 per cent greater than in the same 1943 period, total crude runs to stills were 21 per cent greater, and demand for domestic crude was almost 18 per cent larger. Even with substantial gains in domestic production and imports, the bureau added that total demand for all oils exceeded new supply and stocks of all oils declined 10,000,000 bbl. from Jan. 1 to June 30.

Outstanding factors in the gain in total oil demand are the "enormous" amounts of aviation gasoline required and the rise in fuel oil consumption for naval and shipping purposes, the bureau said.

Daily average supply of domestic crude to meet market demand in September was estimated at 4,790,000 bbl., or 401,600 (9.2 per cent) higher than demand in September 1943. A "substantial" reduction in crude stocks will be necessary to meet this demand, on the basis of present production rates, the bureau said.

September gasoline yield was put at 39.00 per cent, compared with 39.10 forecast for August, and its application to straight-run and cracked gasoline production of 54,950,000 bbl. gives total crude runs of 140,900,000 bbl., or 4,696,700 b/d, and represents a gain of about 12 per cent compared with September 1943.

In reviewing the current situation, the bureau reported that daily average crude production and runs to stills during the four weeks July 2 to July 29 were about 4,601,000 and 4,629,000 bbl., respectively, while during the same period domestic crude stocks dropped 115,000 b/d, indicating a demand for domestic crude of 4,716,000 b/d. A further large gain in domestic crude production and demand is indicated for August, according to statistics now being compiled, the bureau added.

Note Warning Issued

Finished and unfinished gasoline inventories stood at 81,984,000 bbl. on June 30, or 4,354,000 bbl. more than on June 30, 1943 while current statistics indicate a drop of about 1,800,000 bbl. during July. In this connection, the bureau cautioned that "in comparing current gasoline stocks with those of last year, it should be borne in mind that there was an abnormal liquidation of such stocks in the second quarter of 1943 and that any increase this year are proportionately much less than the increase in total demand."

Summary of the bureau's forecast for September compared with August estimates follows (figures in bbls.):

	Forecast September, 1944	Forecast August 1944
Demand for Motor Fuel (1)		
Domestic demand		
Exports		
Total	66,100,000	68,200,000
Supply of Motor Fuel:		
Straight-run and cracked gasoline production	54,950,000	56,380,000
Natural gasoline used at refineries	5,650,000	5,620,000
Total refinery production	60,600,000	62,000,000
Other natural gasoline and imports	2,400,000	2,500,000
Increase in finished stocks		
Decrease in finished stocks	3,100,000	3,700,000
Available supply	66,100,000	68,200,000
Crude-oil Requirements:		
Per cent yield of gasoline from crude	39.00	39.10
Refinery crude required	140,900,000	144,200,000
Daily average	4,696,700	4,651,600
Domestic crude runs	136,900,000	139,900,000
Exports	6,800,000	6,300,000
Fuel and losses		
Total demand for domestic crude	143,700,000	146,200,000
Daily average	4,790,000	4,716,100
Decrease in domestic stocks		
Actual production		
Daily average		

Fuel Oil Rationing

. . . *and the Future of Oil as a Fuel*

TODAY the Fuel Oil Industry stands high in public opinion. 82 per cent of fuel oil consumers, according to a comprehensive survey, believe Fuel Oil Rationing has been well handled, which means we must have done our part well.

But an analysis of public opinion also shows that many people believe that the war in Europe will soon end, and that further rationing will not be needed.

We all hope this will be the case. But our industry cannot afford to bet our business good-will and reputation on it.

The Military High Command does not *know* when the war will end. So it's just good business judgment for us to plan as the High Command does on a war of uncertain and unpredictable date of conclusion. We must plan as they do that the war will continue. And even though the war in Europe ends tomorrow, we still have a vast naval, air and amphibious war to fight in the Pacific. That fight is far from over and will require ever-increasing amounts of petroleum products.

Our industry may face another very tight civilian fuel oil supply situation. Then, again, effective rationing will be important to all of us as an industry. For, obviously, our business will suffer if consumers suffer. We will be blamed if fuel oil consumers are cold.

Public opinion can turn against us if it should turn against Fuel Oil Rationing.

So we must support rationing with all we've got...
How . . .?

You have already heard or will shortly hear from your Petroleum Industry War Council. A Plan has been developed by a special Subcommittee on Fuel Oil Conservation, headed by Mr. J. W. Connolly. Details of that plan will soon be in your hands. We believe you'll agree that it is a practical plan, that you will be glad to help make it work. It will, if you give it your all-out backing.

The very future of the fuel oil business depends on the service we give now under rationing. We're in the 9th inning of a game that's being won. Let's protect our lead, let's hold the good-will that has been earned by hard, intelligent cooperation with rationing.

You know, it should be easy for you to cooperate with this program because, frankly, it is one of the best things you can do for your own particular business. So for dividends after the war—back this Fuel Oil Conservation Campaign NOW!

Subcommittee on Fuel Oil Conservation

PETROLEUM INDUSTRY WAR COUNCIL

Rubber Bureau Within WPB Replaces ORD; James F. Clark To Head New Setup

NPN News Bureau

WASHINGTON—In line with a presidential directive, the Office of Rubber Director, headed by Col. Bradley Dewey, has been wiped out and a Rubber Bureau set up within WPB, J. A. Krug, acting WPB chairman announced over the weekend.

The new WPB Rubber Bureau will be directed by James F. Clark, who has been assistant deputy director of ORD since October 1943, and will function under the direction of WPB's operations vice chairman to oversee industry problems and administration of the rubber order, which controls use of synthetic rubber.

Mr. Krug said the new bureau will "follow closely" the routines and policies of ORD and will, as in the past, act as an over-all claimant agency for industry requirements of special materials as well as synthetic rubber. Operation of synthetic rubber plants and carrying out of research, development and testing, however, will be in the hands of the Rubber Reserve Co., under direction of Commerce Secretary Jones.

Mr. Krug said further that L. D. Tompkins, former deputy rubber director, would act as a consultant to him and to Mr. Clark in connection with the operations of the rubber bureau, and that he had asked Colonel Dewey to head a committee which would serve from time to time upon request as advisors on various problems.

Committee Members Named

Mr. Krug said this committee would be made up of Colonel Dewey, chairman; L. D. Tompkins; Dr. E. R. Gilliland, former assistant rubber director in charge of research and development; E. B. Babcock, former assistant rubber director in charge of product development and conversion, and Dr. C. C. Monrad, former assistant to Dr. Gilliland.

Mr. Tompkins is a former vice president of the United States Rubber Company, Dr. Gilliland is one of the leading chemical engineers of the country and on the faculty of Massachusetts Institute of Technology. Dr. Monrad is in charge of chemical engineering at Carnegie Institute of Technology with a wide experience in the petroleum industry as a consultant. Mr. Babcock, who has from the start directed all problems incident to industry's conversion from crude rubber to synthetics, was for years the chief chemist of the Firestone Tire and Rubber Company with a broad experience in not only the manufacture of rubber goods but also the manufacture of synthetic rubbers, as well as the development and operation of rubber plantations.

Mr. Krug paid tribute to the services to the war effort of Colonel Dewey, who became deputy rubber director on Sept. 29, 1942, and succeeded William M. Jeffers as director of the Office of the Rubber Director on Sept. 15, 1943.

Mr. Krug emphasized that with these men available for consultation he expected that there would be "no hiatus" in operations incident to the rubber industry and that it would be possible for the new rubber bureau to place every emphasis upon the necessity of obtaining at once the maximum number of heavy duty tires now so vital to the whole war program.

Mr. Clark, the new director, has been with the Office of Rubber Director since December, 1942. He became assistant deputy director in October, 1943. From 1925 to 1942, Mr. Clark was associated with W. G. Clark and Co., jewelry manufacturers of North Attleboro, Mass., and its successor, the Clark Lighter Co. He was vice president and director until 1935, when he became associated with Hemphill, Noyes and Co., investment bankers of New York City. From April until December, 1942, he was with the Foreign Funds Control of the Treasury Department.

New U. S. Tank Destroyer Helps Rout Nazis

Special to NPN

FLINT, Mich.—Another ominous weapon, powered by gasoline, has made its appearance on the European battle front. A sturdy and destructive vehicle with lightning maneuverability, it has already had an important part in driving the Nazis out of France.

The new vehicle is known as the "Hellcat" of the Army ground forces. Officially it is described as the M-18. It is a tank destroyer mounting a 76 MM cannon with a 55-mile-an-hour speed and great destructive fire power.

Designed and manufactured by the Buick division of General Motors in co-operation with Army Ordnance and the Tank Destroyer Command, the new tactical weapon has been in secret production at Buick's automobile factories for more than a year.

Its high velocity cannon, mounted in a power traversed heavily armored turret, can smash enemy tanks and pill boxes point blank at several thousand yards. It has effective artillery range of more than seven miles. Its high speed and unusual maneuverability is said to render it one of the most elusive targets in modern warfare. Tactical experts attending a recent demonstration at Flint credit the weapon with great effectiveness in warfare against the Germans.

A close-up of the Army's new Hellcat

Weighing approximately 19 tons with welded armor plate hull and 360 degree turret of the revolving type, the destroyer negotiates the roughest terrain, barriers, deep water, and mud and mountainous, heavily wooded areas with ease. It is claimed by designing engineers and Army Ordnance with exceeding any motorized artillery yet developed.

War correspondents have already reported the Hellcat in operation against the Germans at the time Orleans fell to the American Third Army, and in Gen. Patton's spectacular sweep around Paris.

The vehicle is supported on each side by five track wheel assemblies which roll on an endless steel track. Torsion bars function as springs to resist upward movement of the track wheels, thus supporting the weight of the vehicle and providing, with the aid of shock absorbers, unusual ride control over the roughest terrain.

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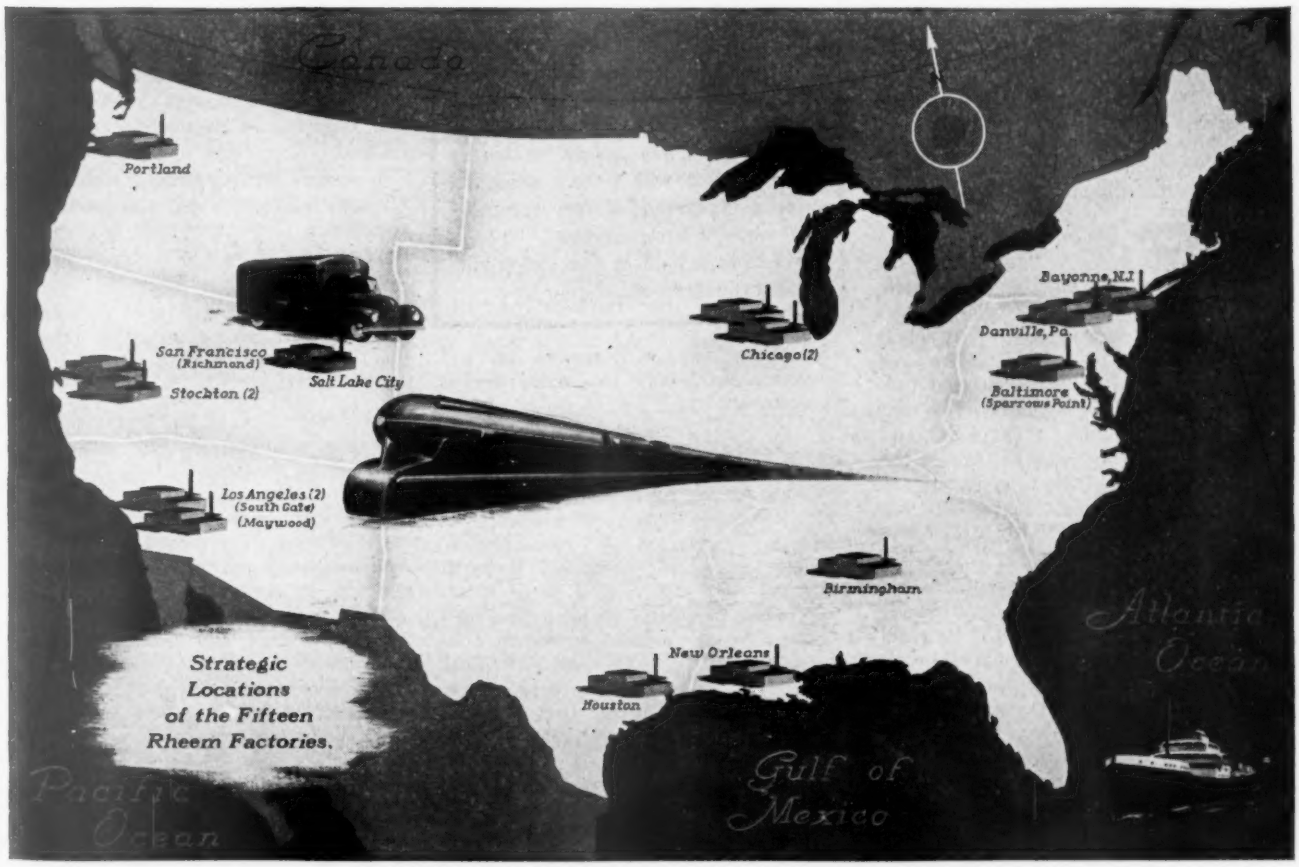


Central Illinois Equipment Needs Boost Growing Postwar Market

Bloomington Marketers Hope To Replace Many Wornout Items When Peace Comes; Expansion Also Figures Largely in Planning

By Earl Lamm
NPN Staff Writer

BLOOMINGTON, I L L. — Reaching out to other central Illinois oil company headquarters cities in an expansion of NPN's survey of needed bulk plant and service station equipment begun at Peoria, it was found that J. C. Sampson, president of the Sampson Oil Co. here is among those aggressive operators who have an eye on the likely possibility that they will soon be able to secure some new underground tanks, computer pumps and other badly needed tools, machinery and fixtures to replace war worn equipment and expand facilities to meet immediate postwar competition.

It has been noted with interest that the long list of items released by WPB on Aug. 15 for production for civilian use includes many things bulk plant and retail outlets require to re-equip themselves and for stock for resale by dealers in accessories and home service items. To mention a few: Automotive maintenance equipment for shops and garages, passenger car jacks, tire gauges, tire pumps, tire tools, lubrication equipment, electrical conduit and fittings (which can be used for improving lights in stations now closed down and which are to be reopened, and for stations which now end their business day at dusk). Some items for resale are oil burners, gasoline flatirons, electric fans, storage batteries, tire chains, cooking utensils and scales.

But returning to Mr. Sampson—he has been in his present location here for 15 years and recently took on the distributorship of Socony-Vacuum products, resulting in increased gasoline sales as recorded in the Illinois gallonage report.

Steps Up Gallonage

His 1941 total was 726,700 gal. of gasoline; 1942, 752,041 gal. and 1943, 1,215,488 gal. Operations are confined to McLean County, except on Kendall oil sales which territory takes in five counties—McLean, Logan, Dewitt, Livingston and part of Grundy. He runs three tank wagons, two bulk plants, and has two commission agents. One of the bulk plants, located on Chestnut St. in Bloomington, he owns. It has 120,000 gal. capacity and is for fuel oil. The other plant with 93,000 gal. capacity belongs to Socony, but Mr. Sampson has it leased.

Some bulk plant equipment is 10 years old, but all tanks are equipped with meters and vapor saving devices. He also owns three service stations and has nine others leased to dealers. He employs 16 men and two women, or eight less than prewar.

Co-ops and major oil companies he called his chief competition, however, there are some trackside operators in this area. Williams Oil-O-Matic, Meadows Manufacturing Co., Portable Elevator and American Foundry are all engaged in war work, but Mr. Sampson has noticed only a small change in population in his trade area—not more than 3000 or 4000 since the war began.

Asked what bulk plant equipment he needs, or would need, "if the war should end right now, today," and the manufacturers had the necessary material to fill his order, he declared the first thing would be 25 550-gal. underground tanks. Since his big storage tanks are already equipped with meters, he said he would need only two new ones as replacements.

Larger underground tanks, computer pumps and lubricating equipment are listed among a large variety of badly needed equipment items by jobbers and retailers in Bloomington, Ill.

Earl Lamm, NPN's Chicago representative, so reports in the accompanying article following a visit to the central Illinois city.

This is the fourth article in the series based on surveys by NPN staffers designed to give some insight into the equipment needs of the marketing branch of the oil industry. To date the surveys have developed that not only is there a great market building up for ordinary equipment in need of replacement but that many forward looking marketers contemplate expansion and are ready to invest in ways that will permit them to meet anticipated stiffer competition when peace comes.

Another article in the series will appear next week.

Needs 24 Computing Pumps

Under service stations, he marked up 24 computing pumps as replacement needs. A Bloomington city ordinance limits new installations of station tanks to 2500 gal. per station and there is no opportunity to enlarge present capacities beyond that. An increase in station storage was voted down by the city council about three weeks ago, Mr. Sampson said. However, he plans to buy two new lifts as soon as they can be had. He has two stations closed now and intends to reopen them as soon as possible as they are located in Bloomington. He has four additional spots selected for construction of new stations and is now awaiting developments on the war and equipment fronts.

"However, there won't be as many highway stations as there was prewar," he declared, "because gasoline will go farther in after-the-war cars and there will be no need for so many stations."

All 12 of the stations owned or serviced by Sampson Oil Co. were in good modern condition three years ago, Mr. Sampson said, but after the war will have to be cleaned up, painted and repaired. His large station at 301 S. Main in Bloomington, in which the company's offices are located, is of late prewar design with some glass brick walls. It is open 24 hrs. daily. His whole setup is probably more up to date than most bulk plants and stations.

However, station, bulk plant and equipment maintenance is now dependent upon tank wagon men and station operators. "We did have a utility man who looked after it," Mr. Sampson said, "but he left two years ago and went to a defense plant."

Employe Turnover Heavy

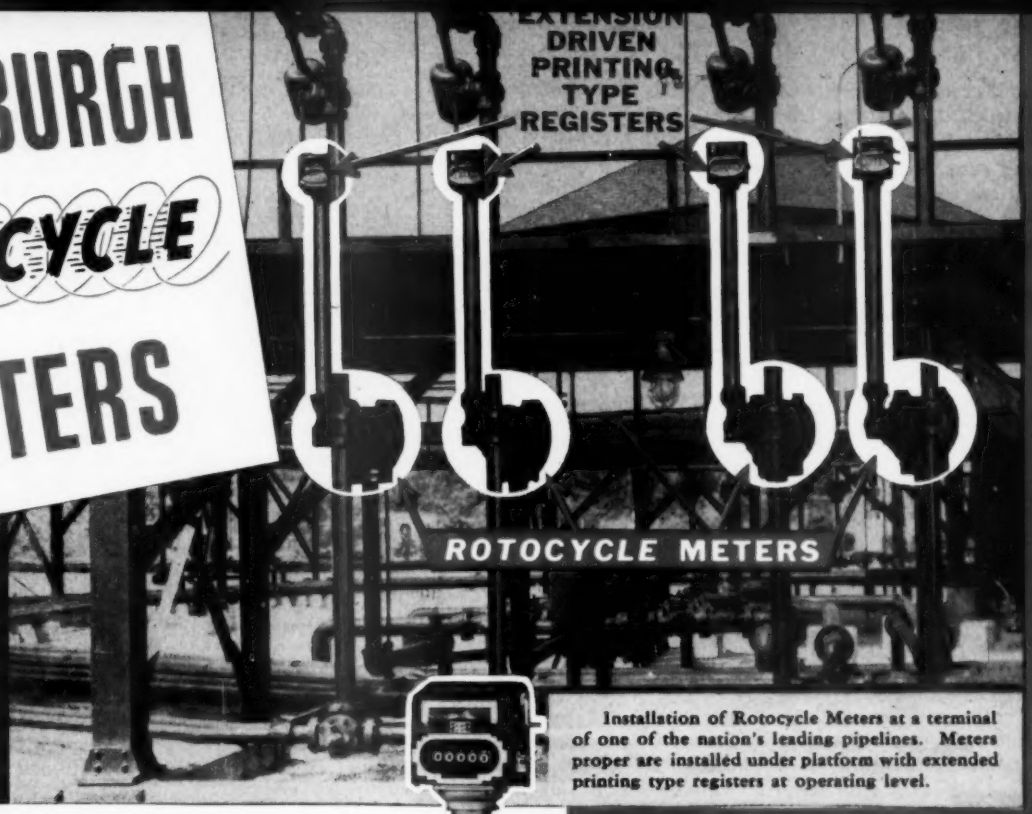
Among the items constantly needed and difficult to get right now, are pump parts for metered pumps and grease gun parts. "Nothing we've tried to obtain has been found really impossible to get," Mr. Sampson recalled, "but we do have to go through a lot of red tape to get it, which costs us a lot of time. Wartime employes as a rule do not take as good care of equipment as prewar employes," he continued "and the help turnover has been big during the past two years. Only three old employes out of 26 are still with the company. New employes stay only five or six months and leave," he said.

Inventory of equipment repair parts for both bulk plants and stations is down to scratch. "We buy only what is absolutely needed now and do well to get that," Mr. Sampson declared.

Paint on buildings, tanks and trucks has been fairly well maintained, although two closed service stations need new coats.

As for transportation, two trucks are six years old and will be replaced as soon as new ones can be had. They have 600 gal. tanks, which also will be replaced with new tanks of 1000 gal. capacity each. The meters, however, are in good shape and will be retained. In addition to these two old trucks, the company owns another with tank capacity of 800 gal. and two of 1000 gal. each, which are in fair condition and in daily operation. "Only parts we need," Mr. Sampson said, "has been small pump parts for motors, and we have not been able to get them. No trucks have been laid up for lack of repair parts, but the frequency and cost of repairs is increasing, just how much I haven't stopped to figure out." But it is a fact, he said,

PITTSBURGH ROTOCYCLE METERS



Installation of Rotocycle Meters at a terminal of one of the nation's leading pipelines. Meters proper are installed under platform with extended printing type registers at operating level.

PERFORMANCE *Proven!*

During these strenuous days, stepped-up throughput demands infallible meters—meters free from breakdowns, clogging, inaccuracies, and premature wear. That's where Rotocycle Meters "fit into your picture". For these sturdy, long-lived, *measurement engineered* products are designed with a stamina that spells success. Whether in service on the battlefields of our far-flung Armed Forces, or installed on pipelines, pipeline terminals, bulk plants, or tank trucks serving the home front, Rotocycle Meters can be relied upon to measure accurately and dependably. Write for literature.

The Heart of the Pittsburgh *ROTOCYCLE* METER

The Rotocycle is the first positive displacement meter to have an operating mechanism consisting entirely of rotating parts. In this design, the measuring element, called the rotor, is turning with the moving stream by the pressure of the incoming fluid acting upon four half-moon shaped vanes, equidistantly spaced on its outer circumference. These vanes are geared together in a ratio of one-to-one on top of the rotor. As the rotor turns, the position of the vanes with relation to the side walls of the circular measuring chamber varies, always, however, so that two vanes are in position to form a closed compartment. Volume in this compartment is a definite displacement and a certain number of these displacements are counted and recorded for every gallon passing through the meter.

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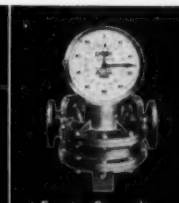
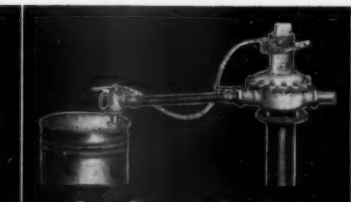
National Meter Division, Brooklyn, N. Y.

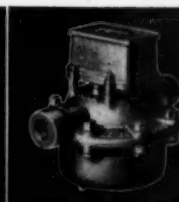
There's A Pittsburgh-National Meter for Every Type of Service

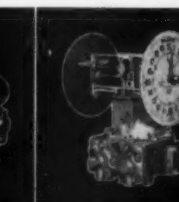
Pittsburgh Rotocycle for Bulk Plants, Tank Trucks

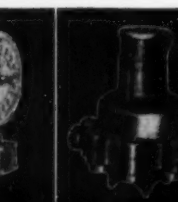
Pittsburgh Rotocycle for Pipe Line Service


Empire Streamline Oscillating Piston for Bulk Plants


Empire Thermostatic Drum Filler for Filling Containers with Petroleum Products


Empire Oscillating Piston for Refinery and Industrial Services


Pittsburgh Reciprocating Piston for Service Station Pumps


Pittsburgh Disc for General Service

MANUFACTURERS OF THE MOST COMPLETE LINE OF PETROLEUM METERS IN THE WORLD

that it costs considerably more to operate old trucks than it does late models.

In order to save mileage and cut operating costs, the city was split into four quarters for delivery truck routing purposes. Outlying routes are handled in much the same way, the truck going out one highway one day each week and another the next. "There is no backtracking for late customers," Mr. Sampson asserted, "and I don't think there will be after the war and present regulations go off."

20% Is Farm Business

Mr. Sampson is a director of the National Oil Marketers' Assn. About 20% of his business, he said, is farm trade. Asked about handling accessory lines after the war, he declared he is going to stay within the limits of his own line—selling gasoline, oil, tires and tire service. "No batteries!" he said.

* * *

Another oil service company operating in the central Illinois area is largely confined to the farm trade since 80% of its business is with farmers. Commercial and consumer business total only 2%. Balance of 18% of total sales is made through 16 service stations, five of which are company owned, another one is leased and company operated, and 10 are outside dealer outlets.

Operations are confined to one county in which the company has been doing business for 17 years. Total sales for 1941 were approximately 4,500,000 gal. of gasoline; 1942, 5,200,000 gal., and 1943 5,000,000 gal. Fuel oil sales for 1942 were 750,000 gal. and 1943 560,000 gal.

There are nine company bulk plants. No. 1 has a capacity of 420,000 gal.; No. 2, 45,000 gal., No. 3, 59,000 gal., No. 4, 45,000 gal., No. 5, 60,000 gal., No. 6, 46,000 gal., No. 7, 59,000 gal., No. 8, 55,000 gal. and No. 9, 58,000 gal., or a grand total of 847,000 gal.

Bulk Plant No. 1, which is at headquarters, has a vapor oil seal for gasoline tanks, and both gasoline and fuel oil tanks are equipped with meters. Nos. 3 and 9 are also equipped with meters. The company manager, who apparently is conservative, says his plants are modern and that he does not contemplate replacement of any tanks and has no plans to add meters, as with the right kind of co-operation from the workmen, the shrinkage problem works out OK without them. "All bulk plants except No. 8 have Simplex Viking gauges, and they will be installed on No. 8 as soon as I can get two of them for that purpose,'" the manager declared.

Retains 28 of 50 Workers

Studying the effects of the war on personnel, it was found that 28 employes out of 50 are still with the company. In view of the company's large farm trade, some employes have been exempted from military service. Overall, there has been a reduction of 10 employes. Five out of the 40 remaining are women compared to three women and 47 men prewar. The manager feels that his principal competition for business is the major companies, although very little is heard now about price, he said.

Total of 19 trucks are working for the company in the county. Two of them are company owned and the remaining 17 belong to country commission agents. The company supplies all truck tanks.

Addition of eight 5000 gal. storage tanks at bulk plants, the manager believed, would eliminate having to switch products about with changes in the season. For instance, No. 1 heating oil has to be removed from a tank in the spring in order to make room for storage of more tractor fuel. In the fall, the switch has to be reversed. Addition of a new tank would make this unnecessary, and a 5000 gal. size would take an entire transport load of products, which are transported from Kingston Mines water terminal.

Likes Centrifugal Pumps

"Also," said the manager, "some farmers like power tractor fuel, and if I had another tank, I could supply it. We now handle only regular tractor fuel."

Last year three centrifugal pumps were installed at bulk plants, and the manager declared he liked them and would like to have four more. Unloading an 8000 gal. transport takes 1¾ hrs. now with a regular 2-inch pump, and a centrifugal pump would do this in 45 minutes, the manager said. The four additional pumps he plans to buy as soon as possible would of course be equipped with electric motors. He said he didn't need any more valves, mixing equipment, loading racks or meters.

However, he wants six gasoline station pumps, five 500 gal. storage tanks and two of 1000 gal. each, which he said he would like very much to have right now. He also is in need of enough lines and pipe and lighting equipment to work over two stations. At one of them the equipment was installed in 1933. The other station is to be relocated at the cross roads on Highway 66. It will be modernized completely. Rest rooms at all stations are to be gone over and dressed up but no major changes are contemplated at this time.

Talking about possible improvements in future station equipment, it was pointed out that the company has two stations with air and water underground on the island, but the water hose nozzle sticks above ground. The station boy is supposed to turn a metal box with a hot light bulb hooked up inside over the water hose nozzle after each time it is used during cold weather. The boys, however, neglect to do this and the hose nozzle froze up several times last winter. How about improving that?

Also, how about air conditioning waiting rooms at highway stations where tourists will stop for gasoline, rest room and cold drinks?

As for this particular company, the manager is thinking about it for the station to be relocated and rebuilt at a cross roads on U. S. Highway 66 as it probably will have to be on a side road or "service drive" on the by-pass at a small town where there probably will be other stores, cafes and oil stations. Other than this, the manager has

A well worn driveway and a wartime battered station, and modern ideas in the form of late model prewar computer pumps indicates a progressive marketer handicapped by wartime restrictions. This is one of many outlets in Central Illinois ready for improvements when conditions permit

Houdry Laboratories offer service on the T.C.C. Process, supplementing similar services offered to Fixed-bed licensees for the past five years.

The T.C.C. process, developed by Socony-Vacuum, is the result of that company's extensive work with thermofor clay burning and 8 years of commercial experience with the Houdry catalytic process. Houdry now offers its licensees engineering service on T.C.C., based on continuous pilot plant operation in our laboratories as well as engineering studies on full-scale equipment.

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HOUDRY CATALYTIC PROCESSES
... FOR VICTORY IN WAR AND PROGRESS IN PEACE

no spots picked out for new stations. Relocation of the one under discussion has been delayed by the war. Other stations were declared fairly modern.

Agents Need New Trucks

Although the commission agents own their trucks, it was believed that 16 out of the 17 agents will buy new trucks as soon as they can get them. The company needs a 1½-ton truck with 750 gal. tank and two extra tanks for commission agents. One of the two company-owned trucks is being overhauled. Both trucks were said to be OK, although one is seven years old and the other 14 years old. The older one delivers fuel oil and is used only four months out of the year. Both trucks are equipped with power take offs, and the company manager thought that when the 16 commission agents bought new trucks, three or four of them would want to switch from their present pump and meter outfits to power take offs. Present truck tank sizes are satisfactory, and it is not anticipated that there will be any switching to larger tanks.

It has been found that truck repair parts are very difficult to get. Repair work is done by a local garage and last year the garage man bought a complete motor merely to salvage a crank shaft. The company's truck now in the shop for overhauling has been out of service for five weeks. Before the war it would have been fixed up in a week. However, the manager pointed out that he had not pushed the work as the truck is not urgently needed at this time.

Opposes Yearly Tradeins

The oil company operates a recapping and vulcanizing outfit, and is now in need of two men in the shop in order to give good service.

Conservative ideas of the manager were evidenced when he was asked if truck operating costs have gone up because he has not been able to replace old equipment with new. "Chance for an argument there!" he declared. "I've always favored running equipment longer rather than trading it in each year."

"About routing trucks to save mileage," he continued, "I have urged our country men to follow a routing system, but in actual practice it doesn't work out so well, except that the drivers do group their calls. Great difficulty with post-war routing," he went on, "is that competition will kill it. As soon as the other fellow gets onto your route, he will try to grab orders by jumping ahead of you. Also, customers will demand more service," he concluded.

The same maintenance man who looked after bulk plant and station equipment before the war began is still on the job, the manager said. "He checks pumps, valves, tests meters once a year and does minor repair work on lifts and air compressors. Big jobs are taken to the local machine shop. Meters really should be tested monthly, but we don't have time," he said.

It took two weeks to get new repair parts for one of the air compressors that broke down recently. It was not thought that repair costs are unreasonable under the present circumstances, although it was believed that more up-to-date equipment, including station pumps, would be more convenient and enable better service to customers. The class of help obtainable now is not so good as prewar. This the oil company manager blamed partly on a "don't care" attitude and a lack of knowledge and training. One good, large account was lost to the company about the first of the year due to lack of manpower to handle it, although the equipment was available.

Inventory of equipment parts has never been very large as the usual practice of ordering from Chicago supply houses has been followed. In stock now are a few valve seats for truck tank faucets and some fibre gears for country truck pumps and meters, and enough gasoline hose to last perhaps for six months, plus two 2-in. gate valves and two anti-freeze valves for bottom of storage tanks.

All Stations To Get Paint

All service stations are due to get a coat of paint as soon as labor is available. Two stations especially need attention now, and so do truck tanks. Garage and body shops were reported crowded. One shop promised to paint three trucks by Oct. 15. "We need 10 trucks painted if they can't be traded for new ones," the manager said, "but it will be spring before we can get the work done. Prices at most paint shops are too high and we will wait for our regular man."

Storage tanks at two bulk plants inspected during course of the over-all survey, needed paint, one of them badly; however, the tanks at this location are to be removed and consolidated with the others before painting, since both small plants are in the same town and pulling them together would be a matter of convenience and less operating cost.

Oil Housing Priorities Regulations Revised

NPN News Bureau

WASHINGTON—PAW last week announced a revised procedure, which is embodied in an amendment to Direction 1 to Preference Rating Order P-98-B, to be followed by petroleum operators in obtaining priorities assistance for materials to be used in repair and construction of industry housing.

The amendment, issued by WPB upon PAW recommendation, permits the use of regular P-98-B maintenance and repair procedure for upkeep of houses owned by oil operators in all branches of the industry and occupied by their employes. A similar privilege, providing for a special material priority, is extended in the revised direction to housing owned and occupied by employes of petroleum operators if the housing is on or adjacent to an oil or gas lease.

For the construction of housing on or adjacent to a lease, the operator will use regular production rating of order P-98-B. An employe will apply for authority to construct housing by writing to PAW district office or the district in which the proposed housing is to be erected.

The employe's letter requesting construction permission should be marked "REF. P-98-B" and should contain the following information:

Name and address of the applicant and of his employer, location of the proposed housing, description of the work to be done, name of the land owner, reason the house is necessary, other work (such as grading) that is required, utility connections that will be required, and the estimated date when work will be begun and finished.

Operators engaged in pipeline operations must obtain approval to use materials for housing by filing PAW Form 30 with appropriate PAW district office. (Copies of this form may be obtained from PAW district office.)

Housing construction by operators engaged in refining, or petroleum marketing will be handled jointly by PAW and the National Housing Agency. Production housing in urban areas also will be handled jointly by PAW and the NHA. For these types of housing, operators will file Form WPB-2896 with the appropriate PAW district office. In addition, operators should file a letter indicating the specific need for housing, the type of work performed by the prospective tenant, and the tenant's annual income.

Jersey Standard Liberalizes Death Benefit Provisions

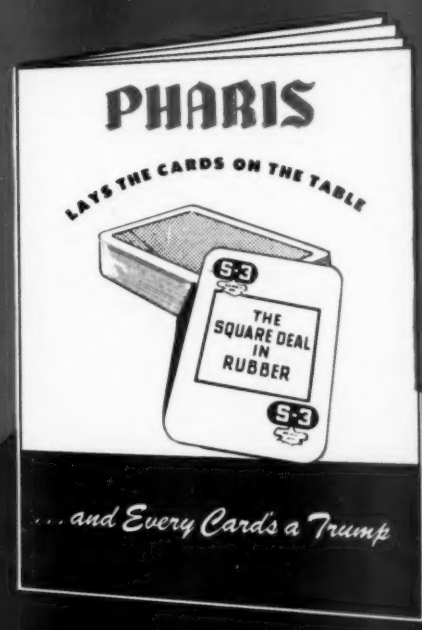
NPN News Bureau

NEW YORK—Standard Oil Company (N.J.) has announced liberalization of its death benefit plan for employes, in which the Carter Oil Co. and the Oklahoma Pipe Line Co., Jersey subsidiaries will participate.

The amended plan provides for the payment of a year's salary to qualifying beneficiaries in the event of death of an employe with five years of service with the company, and in addition a half month's pay for each year of service above five years.

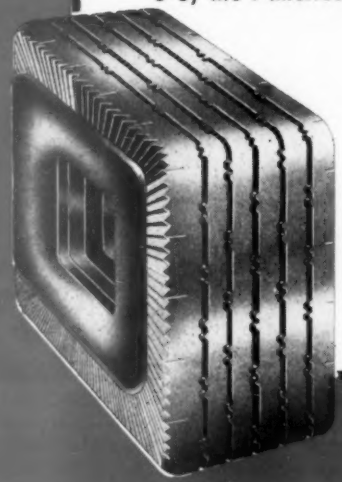
The previous plan provided death benefits equivalent to a full year's salary for all employes with at least five years' service. It, however, specified a maximum benefit payment of $3,000 for those with less than 10 years' service. An employe with ten years' service or more previously was entitled to death benefits equivalent to one year's pay.

ON THE SQUARE



The Pharis square deal in rubber isn't just a fancy phrase. It's a fixed policy that removes any hocus-pocus from tire selling. It takes "on the square" out of the dictionary and puts it into daily practice.

It means money to you because it means business. It's built around the Pharis S-3, the American-made-rubber tire that experts thought could never be so good . . . but is! It's based on year-'round Pharis promotions to get you to first base . . . and home! Write at once for "PHARIS LAYS THE CARDS ON THE TABLE".



THE PHARIS TIRE AND RUBBER COMPANY
NEWARK, OHIO

The PHARIS TIRE

Employer's Role In Taking Back Returning Veterans Explained

Draft Official Tells How Various Laws Are Operating To Give Returning Soldiers Fresh Start; Disabled Already Making Good

By Col. John N. Andrews

When the war ends, the men and women who have been in the service will find several opportunities awaiting them. Some will want to remain in the service. Large numbers of the younger men and women especially will probably wish to resume their education, and extensive plans are being made to provide education and training opportunities for them.

The Servicemen's Readjustment Act of 1944, passed by Congress and signed by the President June 22, provides liberal subsidies for those who wish to resume their education or training. Thousands of the ex-servicemen will resume their old jobs, and employers have already demonstrated the fact that they will be very liberal in restoring their former employes to their old positions. In many instances, steps already have been taken by these employers to provide even better jobs, if possible, for the men than they held at the time they entered service.

Estimates suggest that from 3,000,000 to 4,000,000 men and women who will have served in the armed forces never held permanent jobs. This group will constitute an especial problem for the nation at large, and for the industrial, business and labor leaders particularly.

A considerable number of veterans will need hospitalization and rehabilitation before they can be returned to gainful employment. The Veterans' Administration, under the able leadership of Brig. Gen. Frank T. Hines, is authorized under Public Law 16 to provide hospitalization and rehabilitation for the veterans who have service-connected disabilities and who meet certain requirements.

Caring for the Disabled

Employment is a final goal of the vocational program of the Veterans' Administration. Disabled veterans eligible for vocational rehabilitation under Public Law 16 must have met the following requirements:

a. Active military or naval service after Sept. 16, 1940 and during the present war;

b. A discharge other than dishonorable from active service;

c. A disability incurred in or aggravated by such service for which pension is payable under laws administered by the Veterans' Administration, or would be but for the receipt of retirement pay.

d. A need for vocational rehabilitation to overcome the handicap of such disability.

Maintenance and support during training, and for two months after employability has been determined, will be provided through increased pensions. A single person will receive payment at the rate of $80 a month, a married person $90 a month, with $5 a month for each dependent child and an additional allotment in the amount of $10 for each dependent parent.

In addition to these amounts, payments by employer-trainers to veterans during training-on-the-job are authorized to be made in accordance with certain principles designed to preserve a balance between the amounts which may be paid a claimant during training and those which he may receive in employment after being trained. Loans not exceeding $100 may be made to trainees commencing or undertaking rehabilitation.

Institutional training is generally provided in an institution in or near the veteran's home community. Tuition, books, supplies and other incidentals are furnished in institutional training, and all equipment and supplies required are provided in training-on-the-job. No course of instruction can exceed four years in length, nor shall any training under this legislation be afforded beyond six years after the termination of the present war.

Employers in the oil industry, as in every industry, face many responsibilities imposed by law in the task which is before the nation of fitting some 11,000,000 to 12,000,000 men and women from our armed forces back into civilian life when the war is over. In fact, more than 1,200,000 have already been discharged from active service, many to return to their former jobs or companies.

Many agencies, both state and federal, are also empowered by law to take part in the program for returning service men and women into industrial and other peacetime occupations. Their activities as prescribed by statute are closely related in many instances with the obligations on employing companies.

The part that employers are called on to assume in the demobilization of the armed forces is described in the accompanying article by Col. John N. Andrews, Washington, who is in charge of Postwar Activities for the National Selective Service System. Col. Andrews is on leave of absence from the faculty of New York University and has been associated with the national headquarters of the Selective Service System since 1941. The article is a portion of a paper he presented Aug. 10 before the Industrial Management Conference in York, Pa.

When the war ends, some 15,000,000 veterans will have the right to be hospitalized by the Veterans' Administration when beds are available. At present, the Veterans' Administration has 87,000 hospital beds in its 94 facilities, and it is expected that 104,000 beds will be available in a little more than two years.

It has been estimated that 300,000 beds will be needed to enable veterans of this war to receive hospital and domiciliary care to the same extent as provided for veterans of earlier wars. This peak load, however, will not be reached until about 1975.

The amount of disability pension ordinarily payable ranges from $10 to $100 monthly in multiples of 10, depending upon the degree of disability; i.e. 10%, $10 a month; 20%, $20 a month; etc., to 100%, $100 a month. No man is pensionable whose disability is less than 10%. If a veteran is 100% disabled and needs aid and attendance, he is entitled to $150. (Recent legislation increased the basic pension rates by 15%).

Determining Disability

The percentage of disability is determined by a Rating Board consisting of a medical specialist, a legal specialist and an occupational specialist. The Board rates the disability, assisted by other personnel consisting of clerks and stenographers. The percentage of disability is based upon the average degree of impairment in earning capacity so that there may be no penalty on any individual for his ability to overcome the handicap caused by his disability.

The Vocational Rehabilitation Division of the Federal Security Agency, under the direction of Michael J. Shortley, is authorized under Public Law 113 to provide vocational rehabilitation and training to civilians and veterans alike who meet certain requirements, and who are in need of such vocational rehabilitation and training. The latter program will provide opportunities for the handicapped and other civilian nonveteran workers to be retrained. This program will also be open to the disabled veterans if they desire certain short courses of training, or if their disabilities and vocational handicaps do not meet the requirements of Public Law 16.

Of the more than 1,200,000 men and women already discharged or released from active service, a relatively small proportion have been battle casualties, but this percentage will increase as the fighting is intensified and as our participation in it is extended to wider battle fronts. The prospect of hundreds of thousands of such war-disabled constitutes one of the most appealing social challenges ever presented to the leaders of industry, labor, business, government, social agencies, educators or the medical profession.

The rehabilitation program of the Veterans' Administration is not only a means of enabling individuals to earn their living, but a means of social participation, self-respect, and that individual integrity which is the right of every member of society, and which even to a fuller extent is the right of those who bear service-incurred disabilities. These men, perhaps more than any others, will need to live as normal a life as possible, and it is our obligation to do everything in our power to help them achieve such a life.

Hand-Picked for Job

After the rehabilitation process, these veterans, in most cases, will be as employable as the average worker, if not more employable. While most workers drift into employment, rehabilitated veterans will go into employment after considered and tested advisement. The rehabilitated veteran will be suitable to the occupation for which he is trained. He

(*Continued on p.* 41)

WHEREVER the drums of war beat—in battle zones from tiny islands in the far Pacific to outposts that rim the arctic, must be transported drums of gasoline that are the very life-blood of Victory . . . to help supply this vital fuel, Hanlon-Buchanan is supplying Butanes and Stabilized Natural Gasoline — STA-VOL-ENE the "Natural" known throughout the World.

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Modify Specifications Of W. Coast Fuel Oil

WASHINGTON—PAW this week announced modification of minimum viscosity standards for various grades of fuel oil manufactured, delivered, or received in the Pacific Coast states with issuance of an amended PDO 22 which is effective immediately.

Viscosity minima for various grades of fuel oil listed by amended order follow:

Furnace Oil—Not less than 35 (previously 43) Saybolt seconds universal at 100 deg. Fahrenheit.

Light Domestic Fuel—Remains not less than 35 Saybolt seconds furol at 122 deg. Fahrenheit. The amended order also provides that light domestic fuel of a viscosity of not less than 27 Saybolt seconds furol at 122 deg. Fahrenheit may be manufactured and delivered for non-military use in Los Angeles County.

Bunker Grade Fuel and Industrial Fuel—Not less than a viscosity of 140 (previously 150) Saybolt seconds furol at 122 deg. Fahrenheit. But bunker grade fuel and industrial fuel of a viscosity of not less than 95 Saybolt seconds furol at 122 deg. Fahrenheit may be manufactured and delivered for non-military use in Oregon, Washington, and Alaska.

PAW explained that the original order increases the production of Navy special fuel oil and of feed stock for the manufacture of 100 octane aviation gasoline. Changes in viscosity standards will facilitate the handling of civilian products so as not to interfere with the output of fuel oil for military use, PAW added. The new order will also make it possible to meet certain special conditions in various areas.

The viscosity of industrial fuel oil for non-military use in Washington, Oregon and Alaska was lowered to increase the handling and burning efficiency of the oil in the cold climates of those areas. Another part of the new order contains a special viscosity provision to meet a particular situation in Los Angeles where many fuel oil consumers have special equipment that can use only domestic fuel oil of lighter viscosity than that specified for the West Coast in general.

Growing Importance of Catalytic Reactions In Refining To Be Discussed by Oil Chemists

NPN News Bureau

NEW YORK — A symposium on catalysts used in refining petroleum will be a feature of the meeting of the Division of Petroleum Chemistry of the American Chemical Society in New York, Sept. 11-15. The meeting is in connection with the 108th semi-annual meeting of the Society. Methods for the determination of some of the physical properties of catalysts will be reported as well as their utilization in some of the new refining processes.

The importance that correct laboratory procedure plays in the development of commercial processes and in the evaluation of the performance characteristics of petroleum products is also recognized in the programs of the Petroleum Division. A symposium on bench-scale techniques on distillation will be held Sept. 11, and on lubricating oils and corrosion Sept. 12.

At the general session of the Petroleum Division Sept. 15, one paper on the program will describe the new test methods for the determination of metals in lubricating oils which were developed by a special subcommittee of Committee D-2 on Petroleum Products and Lubricants of the American Society for Testing Materials.

Officers of Petroleum Division of A. C. S.

Chairman of the Petroleum Section of the American Chemical Society, holding its 108th semi-annual meeting in New York, Sept. 11-15, is C. L. Brown, director of research for Standard Oil Co. of Louisiana, Baton Rouge.

R. E. Burk, director of research for Standard Oil Co. of Ohio, Cleveland, is vice chairman; Carey R. Wagner, consultant, Utica, O., is secretary.

Detailed procedures have been worked out for the determination of lead, copper, cadmium, barium, tin, silica, zinc, iron, aluminum, calcium, magnesium and alkali metals in new or used lubricating oils without the interference from other elements present in the oils, such as sulfur, chlorine and phosphorus.

A report will also be presented on studies on a three-component solvent extraction medium in the refining of lubricating oils, the three components being sulfur dioxide, benzene and cyclohexane.

The complete program of the Petroleum Division follows:

SYMPOSIUM ON BENCH-SCALE TECHNIQUE

Distillation

"Laboratory Fractionation at Atmospheric Pressure of Normally Liquid Hydrocarbons", by H. J. Hepp and D. E. Smith, Phillips Petroleum Co.

"A Universal Pressure Rectifying Column", by Edgar S. Byron, John R. Bowman, and James Coull, Mellon Institute and University of Pittsburgh.

"An Automatic Laboratory Fractionating Column", by Victor C. Smith, Arthur L. Glasebrook, Hercules Experiment Station, Hercules Powder Co., Wilmington, Del.; Charles R. Begeman and Wheeler G. Lovell, Research Laboratories Division, General Motors Corp., Detroit.

"Bearing Corrosion Characteristics of Lubricating Oils", by C. M. Loane and J. W. Gaynor, Standard Oil Co. (Indiana), Whiting, Ind.

"Laboratory Evaluation of Oil Deterioration", by R. G. Larsen, Shell Development Co., Emeryville, Cal.

"Laboratory Evaluation of Some Factors Causing Lubricating Oil Deterioration in Engines", by R. E. Burk, E. C. Hughes, W. E. Scovill and J. D. Bartleson, Standard Oil Co. of Ohio.

"Evaluation of Piston Skirt Deposits", by A. C. Scholp, B. J. Conta and C. D. Russell, The Texas Co., Beacon, N. Y.

"Laboratory Corrosion Tests", by R. M. Burns, Bell Telephone Laboratories, New York.

"Laboratory Tests to Predict the Performance of Metals under Service Conditions", by D. M. Sawyer and R. B. Mears, Chemical Metallurgy Division, Aluminum Research Laboratories.

SYMPOSIUM ON CATALYSTS

"The Application of the Carbonium-Ion Theory to the Alkylation of Isoparaffins", by F. G. Ciapetta, The Atlantic Refining Co., Philadelphia.

"Investigation of the Mechanism of Butane Isomerization Using Radioactive Hydrogen as a Tracer", by T. M. Powell and E. B. Reid, California Research Corp.

"Specific Surface and Particle Size Distribution of Various Silica — Alumina Gels", by P. B. Elkin, C. G. Shull, and L. C. Roess, The Texas Co.

"Nitrogen Adsorption Isotherm Studies of a Supported Catalyst and its Support. The Effect of Sintering on Surface Area and Structure", by Herman E. Ries, Jr., Robert A. VanNordstrand, and John W. Teter, Research and Development Dept., Sinclair Refining Co., East Chicago, Ind.

"The Surface of Solids. I. An Absolute Method for the Determination of the Area of a Finely Divided Crystalline Solid. II. A Vapor-Absorption Method for the Determination of the Area of a Solid without the Assumption of a Molecular Area, and the Areas Occupied by Nitrogen and Other Molecules on the Surface of a Solid", by William D. Harkins and George Jura, University of Chicago.

"Carbon Formation in Catalytic Cracking", by Alexis Voorhies, Jr., Standard Oil Co. of Louisiana, Baton Rouge.

"The Fluidized Fixed Bed. A Method for Contacting Solids with Gases and Vapors", by Charles L. Thomas and James Hoekstra, Universal Oil Products Co.

"Polymerization of Ethylene", by V. N. Ipatieff and V. Haensel, Universal Oil Products Co.

"Reactions of Hydrocarbons in the Presence of Cracking Catalysts. V. The Polymerization of Gaseous Olefins", by Charles L. Thomas, Universal Oil Products Co.

"Catalytic Isomerization of 1-Hexene", by Russell G. Hay, and C. W. Mont-

Haul More in '44

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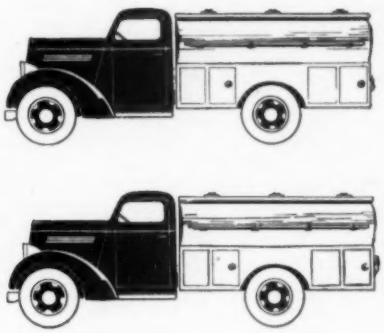

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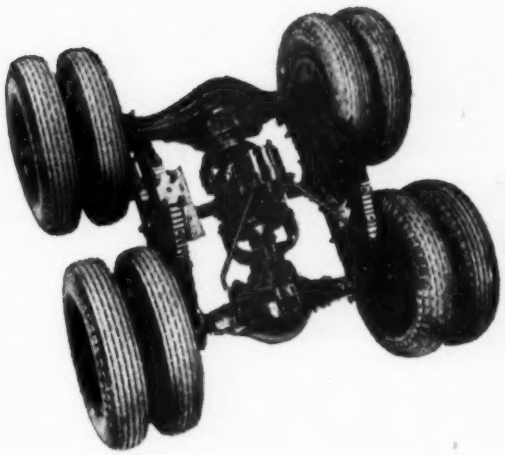

This is the Thornton Drive, consisting of two driving axles, two-speed gear case assembly, "walking beam" type springs; wheels; tires.

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Investigate **THORNTON** *Automatic-Locking* **DIFFERENTIAL** for Replacement in Truck Axles

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Please send me catalog of facts on changing my 1½-2 ton truck into a heavy duty truck.

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gomery, Gulf Research & Development Co., and James Coull, Chemical Engineering Dept., University of Pittsburgh.

"The Commercial Isomerization of Light Paraffins", by B. L. Evering, N. Fragen, and G. S. Weems, Standard Oil Co. (Indiana), Whiting, Ind.

"Catalysis in Synthetic Liquid Fuel Processes", by H. H. Storch, U. S. Bureau of Mines, Pittsburgh, Pa.

"Production of Isoparaffin Hydrocarbons by Cracking of Petroleum Fractions in the Presence of Aluminum Chloride", by V. I. Komarewsky and Lee Warson, Dept. of Chemical Engineering, Illinois Institute of Technology.

"Pilot-Plant Development of the Fluid Catalytic Cracking Process", by L. E. Carlsmith and F. B. Johnson, Standard Oil Co. of Louisiana, Baton Rouge.

"Catalytic Cracking of Cuts from Coastal Crude Oil," by D. B. Ardern, R. H. Newton, and G. L. Barcus, Catalytic Development Corp.

GENERAL

"Determination of Aromatics, Naphthenes, and Paraffins by Refractometric Methods", by R. M. Gooding, N. G. Adams, H. T. Rall, and H. M. Smith, U. S. Bureau of Mines, Bartlesville, Okla.

"Determination of Aromatics in Light Petroleum Distillates by the Use of Specific Dispersions Between the Sodium D Line and the Mercury g Line", by H. M. Thorne, Walter Murphy, and John S. Ball, U. S. Bureau of Mines, Petroleum Experiment Station, Laramie, Wyo.

"Determination of Basic Nitrogen in Hydrocarbon Feed Stocks", by Leon Donn and Harry Levin, The Texas Co., Beacon, N. Y.

"A Method of Determining Carbon in Catalyst Deposits", by James Hoekstra, Universal Oil Products Co.

"Determination of Tetraethyl Lead in Gasoline. Versatile Direct Evaporation Methods", by Louis Lykken, R. S. Treseder, F. D. Tuemmler, and Victor Zahn, Shell Development Co., Emeryville, Calif.

"The Determination of Metals in Lubricating Oils", by K. R. Fitzsimmons, Louis Lykken, and Garrard Wyld, Shell Development Co., Emeryville, Calif.

"Method for Determining the Viscosity Gravity Constant of Petroleum Oils from their Viscosities at 130 deg. F.", by T. A. Petry, Socony-Vacuum Oil Co.

"Critical Solution Temperatures of Solvents with Cyclic Hydrocarbons", by Alfred W. Francis, Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.

"The Discovery and Determination of Neopentane in Refinery Butanes by Infrared Spectroscopy", by L. C. Jones, Jr., R. A. Friedel, and G. P. Hinds, Jr., Houston Refinery Research Laboratory, Shell Oil Co., Houston.

"The Three-Component System, Sulfur Dioxide, Benzene, and Cyclohexane", by Wm. F. Seyer and J. E. R. Lawley, University of British Columbia.

"The Continuous Introduction of Small Amounts of Gases to Bench-Scale Units", by Herman S. Bloch, Alfred E. Hottman, Thaddeus J. Oleszko, and Joseph A. Chenicek, Universal Oil Products Co.

"Production of Heptenes and Heptanes from Propylene and Butylenes", by V. N. Ipatieff and R. E. Schaad, Universal Oil Products Co.

"Effect of Side Reactions on Experimental Isomerization Equilibria", by John R. Bates, Sun Oil Co.

"The Molecular Weights of Asphalts and Their Constituents", by George W. Eckert and Bruce Weetman, The Texas Co., Beacon, N. Y.

"Preparation and Physical Properties of Chlorinated Kerosine", by Raymond M. Dean and Eugene Lieber, Standard Oil Co. of New Jersey, Bayonne.

Army Demands Premium for All Vehicles in U. S.; Fears Effect of Degraded Housebrand on Engines

NPN News Bureau

WASHINGTON—The Army did a flip-flop this week, ordering all motorized equipment at U. S. on-shore bases to switch to the exclusive use of premium gasoline because degraded quality of housebrand threatens damage to engines.

The action will take a 30,000 b/d—or 14 per cent—slice out of the premium gasoline now available for civilian use but will not reduce the quantity of motor fuel now going into civilian channels. According to PAW, the premium supply also should continue to be adequate to meet the needs of trucks and other essential users.

Action Is Explained

The office of the quartermaster general attributed the switch from housebrand to premium to the PAW order of July 14 which placed the maximum octane number of 70 on housebrand, with no control on volatility except in Dist. 1, asserting that in so doing PAW dropped housebrand quality below the minimum requirement of Army transport vehicles.

"The action of the office of the quartermaster general, taken upon recommendation of Army and industry technologists familiar with the Army's equipment and with full support of the War Department committee on liquid fuels, was taken in order to guard against damage to engines which would occur from the use of a sub-standard fuel," an OQM statement said.

"Such damage," it continued, "would be reflected by an increase in maintenance which could not be absorbed at this time, thereby resulting in curtailing of the number of serviceable vehicles which could be shipped to combat areas. Vehicles damaged through use of a substandard fuel in the U. S. might subsequently break down at critical times after being shipped overseas to haul ammunition and supplies."

The announcement went on to say that it is necessary that the Army's "second grade fuel," as distinguished from 80-octane all-purpose, "be available through the normal gasoline distribution system of the petroleum industry due to the large number and dispersal of the installations which use this fuel," and added:

"In order that gasoline meeting the Army specification be available in all sections of the country it is necessary that the quality of at least one grade of civilian gasoline be controlled. It has been recognized that a control on the large volume of housebrand product would be impractical. However, it is believed that the comparatively small amount of premium gasoline can be controlled so that it will meet Army specification in regard to volatility and stability as well as octane number. The Army has requested the Petroleum Administrator for war for assistance in obtaining premium gasoline which meets U. S. Army Specification 2-114A."

80 Octane Needed Abroad

As for using 80-octane all-purpose instead of premium, OQM said it could not exercise this alternative "since overseas requirements of this fighting grade fuel preclude its use in this country for transport vehicles. The performance of this gasoline in combat has been such that every effort will be made to maintain its quality so that the using troops may continue to obtain the maximum performance of their combat vehicles."

At PAW, it was reported that request for a premium gasoline meeting specification 2-114A was under consideration. As of the present, existing PAW specifications are in line with Army requirements but the advent of winter probably will force some revision.

Recent Patents

REFINING

Removing impurities from hydrocarbons. Claudius H. M. Roberts, Palos Verdes Estates, Calif., assignor to Petrolite Corp., Ltd. Filed Aug. 21, 1939. No. 2,355,678.

Production of ketones. Alva C. Byrns, Palos Verdes Estates, Calif., assignor to Union Oil Co. (Calif.). Filed May 6, 1941. No. 2,355,703.

Catalytic apparatus. George Roberts, Jr., Montclair, N. J., assignor to M. W. Kellog Co. Filed March 20, 1940. No. 2,355,753.

Activation of catalysts. Vanderveer Voorhees, Homewood, Ill., assignor to Standard Oil Co. (Ind.). Filed Oct. 23, 1941. No. 2,355,831.

Hydrogen halide recovery. Karl H. Hachmuth, Bartlesville, Okla., assignor to Phillips Petroleum Co. Filed March 10, 1942. No. 2,355,857.

Catalytic hydrocarbon reactions and catalysts therefor. James M. Jean, Altadena, Calif. Filed Feb. 12, 1940. No. 2,355,868.

Polymerization process. James A. Reid, Bartlesville, Okla., assignor to Phillips Petroleum Co. Filed July 14, 1941. No. 2,355,925.

Conversion of hydrocarbons. Gustav Egloff and Vasili Komarewsky, Chicago, Ill., assignors to Universal Oil Products Co. Filed Jan. 27, 1941. No. 2,355,961.

Conversion of hydrocarbons. Herman Pines and Vladimir N. Ipatieff, Chicago, Ill., assignors to Universal Oil Products Co. Filed Aug. 20, 1942. No. 2,356,001.

Conversion of hydrocarbon oils. John W. Ward, Chicago, Ill., assignor to Universal Oil Products Co. Filed Feb. 24, 1941. No. 2,356,019.

Purification of hydrocarbon liquids. Walter A. Schulze, Bartlesville, Okla., assignor to Phillips Petroleum Co. Filed Jan. 27, 1942. No. 2,356,095.

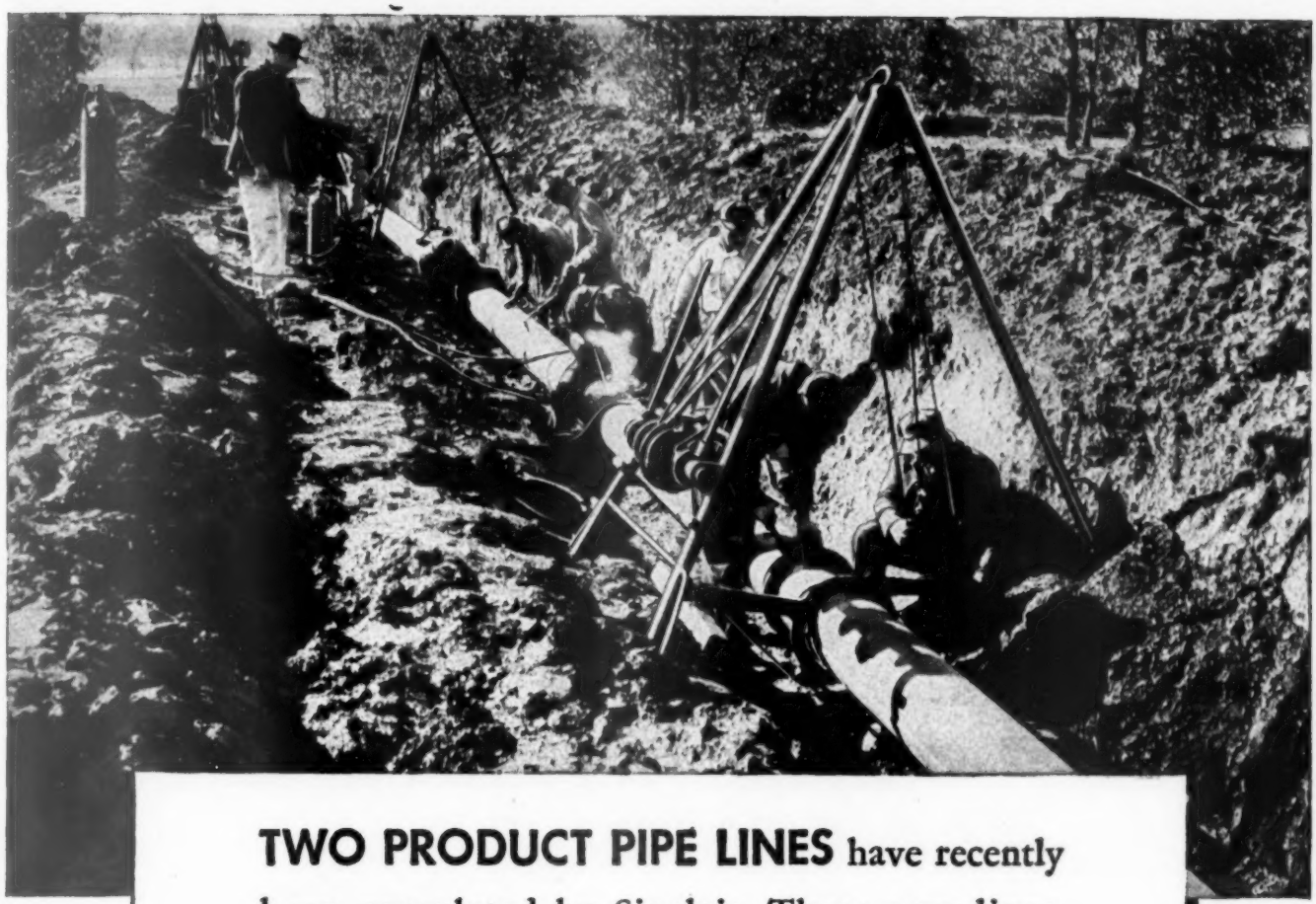
MISCELLANEOUS

Lubricant. George E. Barker, Pittsburgh, Pa., assignor to Elgin National Watch Co. Filed Dec. 28, 1940. No. 2,355,616.

Breaking petroleum emulsions. Henry G. Berger and Paul M. Goodhue, Woodbury, N. J., assignors to Socony-Vacuum Oil Co. Filed March 31, 1943. No. 2,355,778.

Low temperature lubricants. John D. Morgan. South Orange, N. J., assignor to Cities Service Oil Co. Filed Sept. 16, 1942. No. 2,355,993.

Compiled by R. E. Burnham, patent and trade-mark attorney, 511 11th street, NW, Washington 4, D. C., from whom copies may be obtained at rate of 25c each. State number of patent and name of inventor when ordering.



TWO PRODUCT PIPE LINES have recently been completed by Sinclair. These new lines, added to the Company's already existing 14,000 miles of crude oil lines, provide Sinclair with the most extensive pipe line system in the United States, operated by a single oil Company.

FREE BOOKLET — "Sinclair In War and In Peace," pictures and describes Sinclair's facilities in the fields of production, refining, transportation and distribution. Its 40 pages include pictures and description of new Sinclair equipment for the manufacture of 100-octane aviation gasoline and components for synthetic rubber. For your free copy, write to Sinclair Oil Corporation, Dept. D, 630 Fifth Avenue, New York 20, N. Y.

SINCLAIR

Refueling a Spitfire for Another Joust With Nazis

British Combine Photo

Emptying "blitz" cans of high octane fuel into this Spitfire after a "scramble" with the fleeing Nazis in France are Aircraftsman Robert Simmonds, flight mechanic, from Oxford (on wing) and Leading Aircraftsman Ken Townsend, flight mechanic from Bristol

Dist. 2 September Crude Sharing Quota Declines

NPN News Bureau

CHICAGO — District 2 crude sharing quotas for September, released this week by PAW, show a total of 21,795 b/d of crude oil being supplied 16 crude-poor refiners from crude surpluses of 14 supplying companies. Quota shows 6,825 b/d decrease in the amount as compared to 28,620 total for month of August which was, in turn, 4,945 b/d over the July figure.

PAW again extended to District 2 refiners authorization to run 100% or more of normal crude runs through September, provided necessary crude is available. Originial lifting of restriction on refinery runs from 80% to 100% where crude was available was authorized in PAW's wire to the refiners on May 25 and the extension for the month of September only was covered in another PAW wire to the refiners, dated Aug. 28.

Companies involved and quotas are:

	Receiving Co.	Am't.
Aetna Oil Co.	Louisville Refg. Co.	850
Gulf Oil Co.	Arrow Petroleum Co.	1310
Ohio Oil Co.	National Refg. Co.	2000
Pure Oil Co.	Midwest Refg. Co.	1015
Shell Oil Co.	Derby Oil Co.	880
	El Dorado Refg. Co.	500
	Aurora Gasoline Co.	1000
Sinclair Refg. Co.	Worth Refg. Co.	2600
Socony-Vacuum Oil Co. (White Star Div.)	Naph-Sol Refg. Co.	250
Shell Oil Co.	El Dorado Refg. Co.	500
Standard Oil Co. (Ohio)	Advance Refg. Co.	1800
	Pana Refg. Co.	390
	Stoll Oil Refg. Co.	1000
	Old Dutch Refg. Co.	200
Aurora Gasoline Co.	Lakeside Refg. Co.	250
	Marvel Refg. Co.	650
	Old Dutch Refg. Co.	100
Rayburn Pipeline Co.	Crystal Refg. Co.	1300
	Lakeside Refg. Co.	200
Texas Co.	National Refg. Co.	200
Standard Oil Co. (Indiana)	National Refg. Co.	2000
Magnolia Pipeline Co.	National Refg. Co.	1000

W. A. Johnson Heads Technical Group of Penn Grade Assn.

Special to NPN

STATE COLLEGE, PA.—At a meeting here dealing primarily with refining problems of the Pennsylvania Grade industry covering present and postwar markets, W. A. Johnson, Bradford Penn Refining Corp., was elected chairman of the Technical Advisory committee of the Pennsylvania Grade Crude Oil Assn. The meeting was held at the State College petroleum refinery laboratory here.

Mr. Johnson succeeds Frank J. Philippbar, Bradford, Pa., who resigned. G. M. Kirkwood, Pennsylvania Refining Co., was elected vice chairman.

In addition to Dr. M. R. Fonske, director of the petroleum refinery laboratory of the Pennsylvania State College, and R. E. Hersh, E. F. Koch and N. D. Lawson of Dr. Fonske's staff, the following were present at the meeting:

R. Allmendinger, Allegany Refiners, Inc., Bolivar, N. Y.; L. C. Borrell, Franklin Creek Rfg. Corp., Franklin, Pa.; L. M. Baltzoll, Wolf's Head Oil Refining Co., T. J. Harkins, The Pennzoil Co., Oil City, Pa.; L. A. Calkins, Valvoline Oil Co.; P. W. Emory, Elk Refining Co., Charleston, W. Va.; C. W. Georgi, Quaker State Oil Refining Corp., Buffalo, N. Y.; L. E. Grimmer, National Refining Co., Findlay, Ohio; B. L. Heath, Freedom Oil Co., Freedom, Pa.; H. L. Hemmingway and J. A. Jones, Kendall Refining Co., Bradford, Pa.; A. Kinsel, Daugherty Refinery, Petrolia, Pa.; A. W. Lewis, Tide Water Associated Oil Co., Bayonne, N. J.; A. Mondock, Canfield Oil Co., Cleveland, Ohio; and Mr. Johnston and Mr. Kirkwood.

W. C. Wenzel, executive manager of the association, called the meeting and was in charge of all arrangements.

Buys Kentucky Skimming Plant To Handle New Clinton Oil

Special to NPN

LOUISVILLE, Ky.—A 150-bbl. skimming plant used during the Wolf Creek dam construction period has been purchased by the Bell Roberts Oil Co. here.

The plant is at Dresda in Clinton County, a few miles from the Albany field, in which five wells have recently been completed with a total initial production of 120 b/d natural. There are now 20 wells drilling in Clinton County.

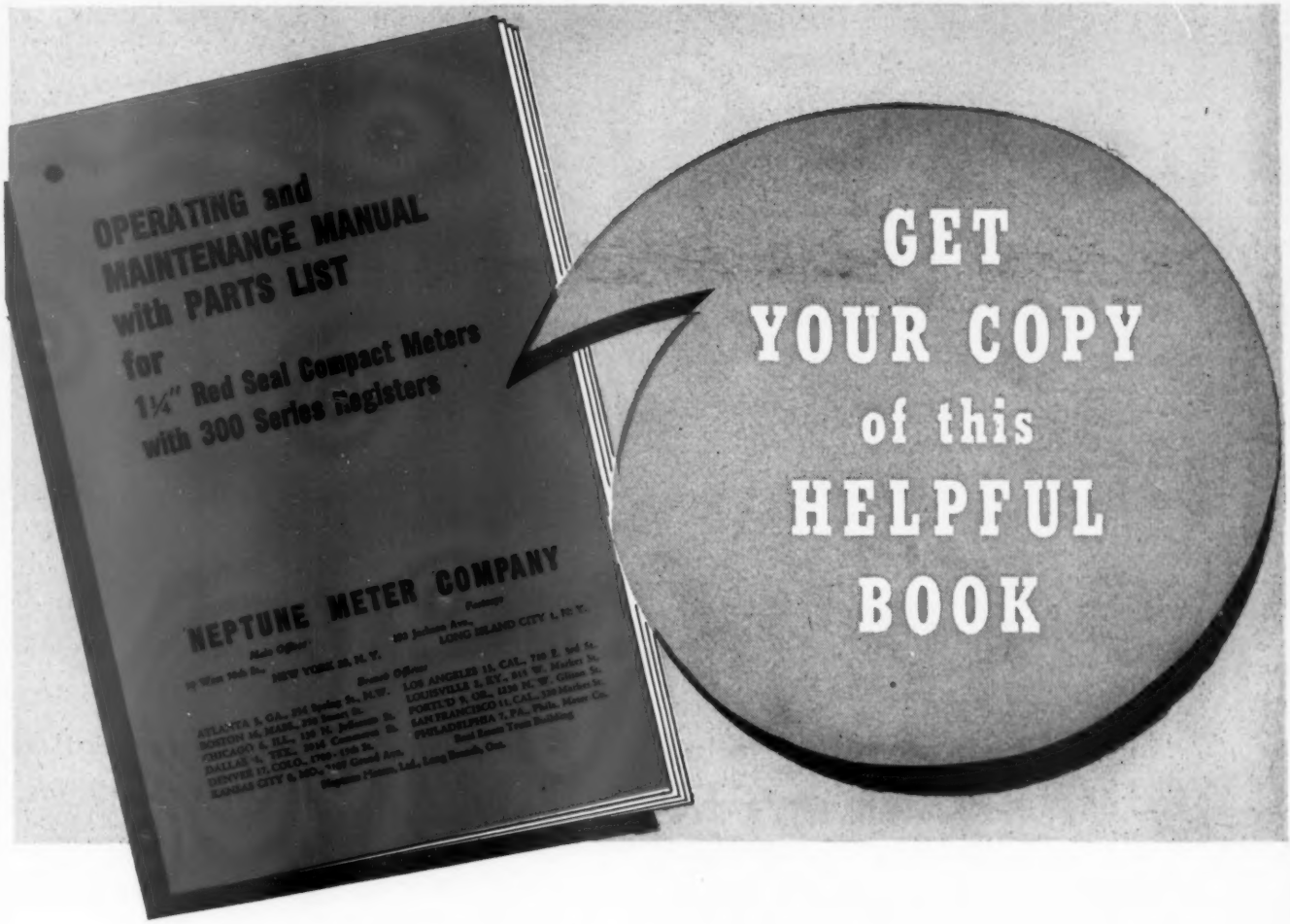
The plant has been reconditioned, and it is reported that the new owners will begin buying and refining crude at once.

Explosives Demand Cited In Civilian Toluene Cut

NPN News Bureau

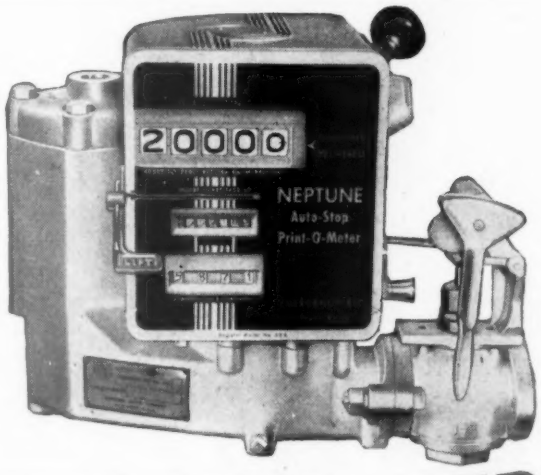
WASHINGTON—WPB announced this week drastic cuts in civilian allotments of benzene, toluene and xylene, to meet increased military requirements for these chemicals in aviation gasoline and explosives. The curtailments will be necessary until April 1, 1945, it was indicated.

Expanded ordnance requirements for toluene in production of TNT are being met with corresponding reductions in civilian allotments for various uses and WPB warned it may reduce amounts of toluene for manufacture of aviation gasoline, to release larger quantities for explosives. WPB is now hoping to increase the output of xylene but meanwhile is reducing amounts for civilian use.



Here is an operating and maintenance manual designed specifically to assist users of 1¼ inch Red Seal Compact Meters. It is fully illustrated to supplement the detailed instructions regarding the installation, cleaning and general operation of these Neptune Meters.

Send for this practical guide to continued meter accuracy. You will find it extremely valuable in helping to keep your Red Seal equipment at its original peak performance. A letter will bring your copy by return mail. Ask for form 772-3SM.



FACTS ABOUT THE 1¼" RED SEAL COMPACT METER

This is a 1¼ inch Red Seal Compact Meter with Auto-Stop Print-O-Meter Register Model 334. Strainer, air release valve and back pressure valve are built into the meter casing—save valuable pay-load space and weight. Auto-Stop feature permits automatic delivery of pre-set gallonage. Print-O-Meter provides fool-proof printed ticket showing exact quantity delivered. However, meter can be bought without Print-O-Meter attachment.

The construction of the measuring chamber is extremely simple—the piston is the only moving part. Unsurpassed accuracy and long life are assured.

Write for new catalog of Red Seal Meters for tank trucks and bulk plants. Form 777.

N-31-44

NEPTUNE RED SEAL METERS

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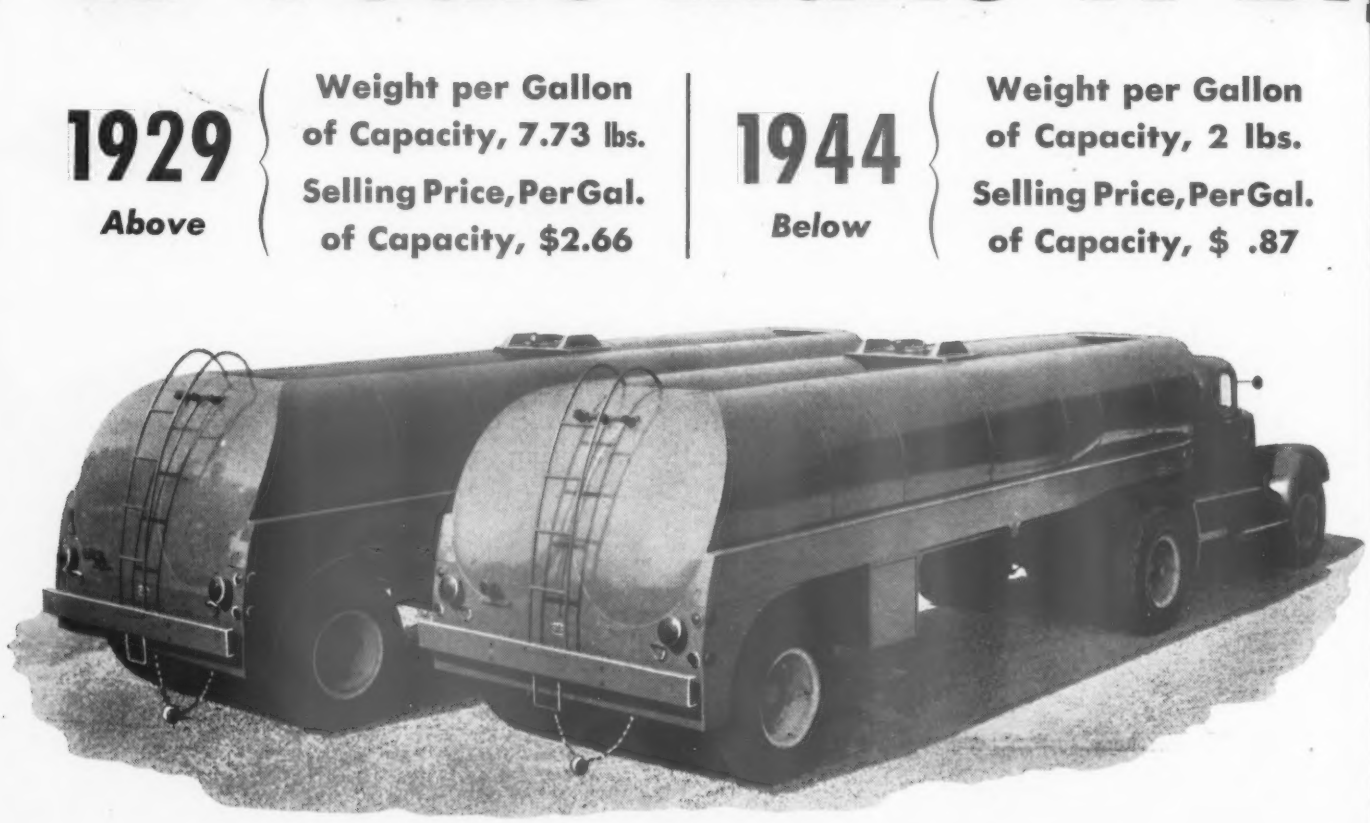
Branches: Atlanta, Boston, Chicago, Dallas, Denver, Kansas City, Mo., Los Angeles, Louisville, Philadelphia, Portland, Ore., San Francisco, Long Branch, Ontario.

15 Years Make A Bi

1929 *Above*
Weight per Gallon of Capacity, 7.73 lbs.
Selling Price, Per Gal. of Capacity, $2.66

1944 *Below*
Weight per Gallon of Capacity, 2 lbs.
Selling Price, Per Gal. of Capacity, $ .87



BUTLER BUILT

BUTLER MANUFACTURING COMPANY . . . Factories: KANSAS CITY, MO.

Big Difference

Old 3946, shown at the left above, helped blaze a trail in petroleum transportation. And, she did it under a considerable weight handicap. As a matter of fact, her deadweight was nearly 25% greater than the liveload she carried. Even though her cost per gallon totaled $2.66, she proved an economical investment.

As made today for rugged wartime service, Butler Safety Transports weigh less than a third of their liveload capacity while their cost per gallon of capacity has decreased 67%. The factor of safety stands at 20 to 1.

Armed with new ammunition in the form of lighter weight material and new construction methods, you can depend upon Butler engineers to resume the battle against deadweight and for lower cost, safer gasoline transportation. Address all inquiries to 7454 East 13th St., Kansas City 3, Mo., or 954 Sixth Ave. S. E., Minneapolis 14, Minn.

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KANSAS CITY 3, MISSOURI
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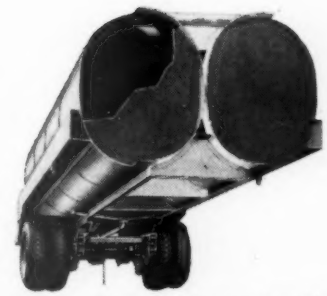
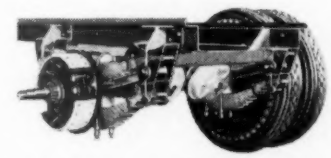
ARMY E NAVY
Awarded to Two Butler Plants



Butler Twin-Tank construction gives you the only transport with I-beam integral frame deeper than the tank body and a 20 to 1 factor of safety.



Two-Step Springing gives Butler Twin-Tank Safety Transport a soft, floating ride when traveling empty — frees it of road shocks, lengthens its life.

TWIN-TANK *Safety* TRANSPORTS

GALESBURG, ILL...MINNEAPOLIS, MINN. Sales Offices: WASHINGTON CHICAGO RALEIGH, N. C. SHREVEPORT

Pipelines Carry More Products But 'Gas' Stocks Remain Tight

NPN News Bureau

WASHINGTON — PAW this week revealed that civilian grade gasoline began arriving in East Coast terminal tankage on Aug. 28 via the Little Big Inch pipeline and when completed the batch will total 325,000 bbl. PAW said that with lighter products in the line, and increased pumping rate of about 220,000 b/d is expected.

During the week ended Aug. 26, the products line handled an average of 206,371 b/d compared with 178,321 b/d the previous week. The Big Inch crude line pumped an average of 321,665 b/d during same week compared with average of 306,900 b/d the previous week. Completion of repairs of damage caused by an electrical storm at the Atlantic, Tex., station accounts for increased pumping, PAW said.

At the same time, Deputy PAW Davies warned that the nation's stockpile of civilian gasoline is at a point where any further increase in military demands will result in "a very tight situation for civilians."

"Although refineries are turning out products in larger quantities than ever before, the unprecedented military demands have limited the quantity of gasoline available for civilians," he added.

"An example of this can be found in the all-purpose military gasoline that fuels the Army's motorized campaign. Manufacture of three barrels of this all-purpose gasoline results in the loss to civilians of four barrels of motor gasoline.

"Another illustration is the refining of 100-octane aviation gasoline, the output of which has been increased more than 1000 per cent since Pearl Harbor. The manufacture of three barrels of 100-octane gasoline results in the loss to civilians of five barrels of motor gasoline."

From July 1 to Aug. 19, stocks of civilian grade motor gasoline held at refineries and terminals in the U. S. dropped 4,417,000 bbls. Total civilian stocks as of Aug. 19 were 41,857,000 bbls., compared with 43,123,000 bbls. during previous week. Stocks are now 40 per cent below the pre-war level of August, 1941, PAW said.

2 Gulf Workers Die in Blast

Special to NPN

PORT ARTHUR, Tex. — Two men died and 15 others were sent to the hospital here Aug. 31 after an ammonia tank car on a railway siding sprung a leak at the Gulf Oil Co. refinery here.

Charles R. Stevens, 59, of Port Acres, one of those sent to the hospital, died a day later. The first victim was William H. Trude, 49, who died in the hospital soon after arrival. Officials now believe the accident happened when a switch engine struck a pipe on the ammonia car sitting on the sidings.

227 Truck Units Down As Tire Shortage Grips Chicago Area

NPN News Bureau

CHICAGO—An ODT survey of truck tire shortage in Chicago area reveals that 227 trucks, trailers and other "over the road" motor equipment engaged in essential transportation are now down for lack of tires. Survey indicated that oil, steel and milk haulers are the major lines affected in the threatened transportation breakdown.

"We have received encouraging reports that as a result of care taken, some haulers have added 5,000 miles to the wear given their new tires. The next 60 days will be a test of how well the industry can conserve the truck tire supply," Marion W. Isbell, acting director for OPA's Chicago metropolitan district said, adding that only 2,022 truck tires were allocated the Chicago metropolitan area for September, out of the nation's supply of 102,000 heavy duty tires.

Coincident with release of the information as to extent of truck tire shortage in this area, Mr. Isbell announced the appointment of an eleven-man motor transport advisory council to work with OPA in the issuance of tire certificates to truck operators in the area. Committee, which went into operation Aug. 31 at meeting with OPA rationing representatives, will meet with OPA tire rationing officials every week through the next two months to analyze the extent of the emergency and make recommendations to OPA, in order to insure issuance of tire certificates first to those haulers in essential industry who are observing the tire conservation regulations in every respect. ODT and the Bureau of Motor Carriers of the Interstate Commerce Commission will co-operate with the committee.

The committee is made up of the following: Cecil Davis and N. Sprout, Petroleum Haulers Association; Gen Leventhal and R. B. Thornton, Central Motor Freight Association; A. P. Nelson and Walter McCarran, Illinois Motor Truck Operators Association; Arthur Sorenson and Earl Girard, Suburban Carriers Association; Floyd Erstsman, Motor Truck Owners Association; Charles J. Holland, Chicago Coal Merchants Association; and Norvel Trimborn, Tire Dealers, Inc. No chairman was designated.

Rail Hauls at Lowest Point in 8 Months

NPN News Bureau

WASHINGTON—Dropping below 600,000 b/d for second time since March 25, 1942, tank car shipments to Dist. 1 declined during week ended Aug. 26 to an average of 593,425 b/d, down 24,623 b/d from previous week.

Last time shipments were under the 600,000 bbl. mark was in week of Dec. 25, 1943, when average was 570,815 b/d. March 25, 1942 average was only 564,750 b/d.

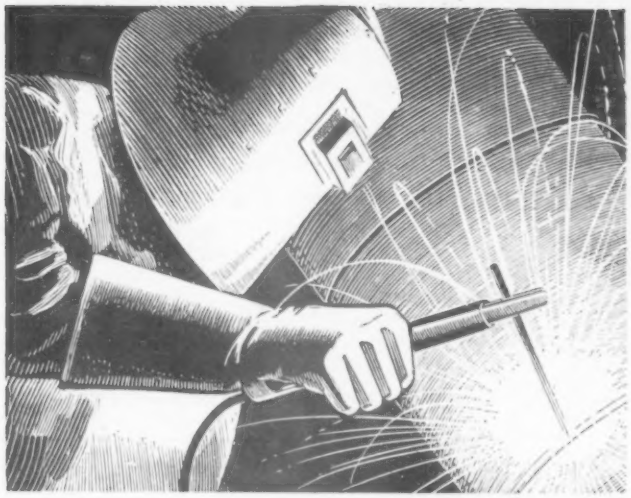
Aetna	25	Drake	5	Republic	84
Allied	57	Eastern	59	Richfield	87
Amsco	173	Eldorado	7	Rock Island	5
Arkansas Fuel	4	Elk Refining	18	Roosevelt Oil	6
Ashland Refining	149	Freedom Oil	6	Root	110
Asiatic Petroleum	68	Gulf	1528	Royal Petroleum	33
Associated	169	Hartol	56	Shell	912
Atlantic Refining	1666	Hess, Inc.	12	Shotmeyer	1
Aurora	36	Jenny Mnfg. Co.	43	Sinclair	301
James B. Berry Sons	6	Midwest	6	Socony-Vacuum	2653
Cantelou	10	Ohio Oil	24	S. O. California	2
Canton	11	Pacific	79	S. O. Indiana	682
Chalmette	22	Pan American	1107	S. O. Kentucky	56
Cities Service Oil Co.	502	Pana	8	S. O. New Jersey	3524
Cities Service Refining Corp.	148	Petroleum Heat & Power	12	S. O. Ohio	232
Continental	470	Phillips	146	Sun	1940
Cosden	45	Premier	1	Talco	50
Crown	3	Primrose	12	Texas	1425
Daugherty	26	Pure	165	Tide Water	233
				Triangle	6
				United	47

P.I.W.C. Announces Sectional Pipeline Maps to Cover U. S.

NPN News Bureau

WASHINGTON — Sectional pipeline maps for the United States, being underwritten by P.I.W.C., are in the course of preparation, Allan H. Hand, P.I.W.C. secretary-treasurer, has announced.

P.I.W.C., it was said, was underwriting the preparation and printing of sectional maps on a scale of 1 inch to 24 miles because of the critical need for up-to-date and accurate petroleum information on pipelines. The Central



X-ray marks the spot!

SPOT? SPOTS to the Nth degree would be more accurate! For to date X-rays covering more than fifty-five thousand feet of continuous field welding have been taken by the M. W. Kellogg Welding Control Section.

This tremendous task is just one undertaken to provide an independent, qualitative double-check on structural perfection in the field. And this ability to spare no detail in refining construction—where details are legion and vital—helps to explain why this company has been chosen again and again to do the job.

X-ray field welding control is a clue, too, to the flexibility of thinking and procedure that characterizes Kellogg construction. For when the size of modern vessels outstripped transportation facilities . . . this company pioneered field welding to metallurgical laboratory specifications.

Such flexibility has built an organization under *one* roof capable of raising the world's ultra-modern refinery on the site of virgin forest. America's 100-Octane Colossus at Lake Charles stands witness. Far beyond basic girders, piping and vessels . . . Kellogg construction engineers have the seasoned experience that takes in its stride, literally anything and everything to make a refinery function—railroad spurs, docks, chimneys, power plants, housing, sewers, concrete construction. And under these construction engineers are permanent crews geared to operate world-wide.

But as leading refiners will tell you—construction is only one phase of M. W. Kellogg Complete* Service. We evolve the required engineering data. We apply it. We develop process methods. We design. We erect the plant. We supervise initial operation. And every phase is fused to meet two interlocking aims: Total war production now; the initial advantage in post-war competition for our customers.

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★Only Kellogg Service Has Them All

★**LABORATORIES**—fully equipped and staffed—devoted exclusively to chemical engineering and process development.

★**24-HOUR-A-DAY PILOT PLANTS**—17 refining processes operating continuously—providing accurate data for commercial scale application.

★**EXCLUSIVE CHEMICAL ENGINEERING DATA**—Continuously compiled . . . embracing both pilot plant runs and the operation of Kellogg-built refineries. Data extends from beginning of modern refining.

★**PROCESS ENGINEERS**—Specialists who have continuously made major contributions to oil refining development, for more than 20 years . . . currently exemplified by their work on fluid catalytic-cracking.

★**MECHANICAL ENGINEERS**—Kellogg installations—worth hundreds of millions—are their best reference.

★**METALLURGICAL LABORATORY**—Establishes continuous check of specifications...creates new techniques for the fabrication of refining equipment.

★**PERMANENT CONSTRUCTION CREWS**—Geared to function all over the world on single units or multiphase refineries . . . team-experience cuts costs, speeds construction.

★**OPERATING STAFFS**—Specialists at placing new units "on stream" . . . training of refiner's own operating crews.

★**LICENSING SERVICE**—Licenses available through Kellogg as Licensor or licensing agent for all types of refining processes.

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States section, which is 50 inches wide by 80 inches high and includes Rocky Mountain facilities, has been prepared by Shell Pipe Line Corp., the announcement said.

An advance copy of the section shows all crude oil and products pipelines and pump stations, and all oil fields, refineries, products terminals and marine terminals.

Line sizes are marked. The location of each line and pump station is plotted with an accuracy never before approached on a map of such wide coverage, P.I.W.C. says. Other than in the most congested sections, they are depicted as near as practicable in their true alignments.

P.I.W.C. says that, because the action of the council provides that such costs are to be recovered, without profit, through the sale of blue-prints as well as negatives and positives for duplication, firm prices for this section cannot be quoted until the approximate number of each to be ordered can be determined. All companies, agencies and individuals interested are asked to advise the number of maps they may require so that prices may be determined.

Mr. Hand, addressed at 1625 K. Street, Northwest, Washington 6, D. C., will be glad to furnish those interested with more details.

PAW's Decision Expected Soon On West Edmonds Pipeline

NPN News Bureau

CHICAGO — Decision is momentarily expected from PAW Vandeveer on whether or not a permit will be approved for construction of the additional trunk pipeline from the West Edmonds, Okla., field as PAW has completed the collection of data on present and potential production of the field which Mr. Vandeveer said he needed before a decision could be reached on the proposed pipeline construction permit.

Following the meeting of pipeline operators here in August, Carter, Sohio and Phillips representatives tentatively agreed jointly to construct the new pipeline if PAW authorized the use of necessary critical material and manpower. Since then, a new joint proposal has been received from Sohio and Phillips only and decision is now being held up pending receipt of word from Carter as to whether or not that company has definitely dropped out.

PAW figures, which Mr. Vandeveer called "very conservative" show estimated production for December at 28,500 b/d from 234 wells. By April, 1945, production is expected to increase to 60,000 b/d from 333 wells. Calculations are based on average of 183 b/d per well since some wells producing from other than Hunton lime and others with high gas-oil ratio and a few edge wells are making less than allowable of 200 b/d.

Cumulative production to July 1 was 2,334,859 bbls. with estimate of 7,388,000 bbls. by Jan. 1, 1945, and 100,000,000 bbls. by Jan. 1, 1960 when the field is expected to be about depleted.

PAW's figures show an average number of drilling wells in the field during August was 80, with September estimate of 90 and for October, 100 wells. Other industry figures from the field show 124 producers as of Sept. 1 and six dry holes.

With the above prospective production figures before him, it apparently is going to be difficult for PAW to long continue refusal of a permit for construction of the additional trunk line. The permit was first refused by PAW, Washington, last spring and the matter later referred to PAW here and authority again declined at a meeting with pipeliners in May. At the August meeting with pipeliners, Champlin gave the maximum of their present line as 60,000 b/d when pumping oil in two directions—north from the north end of field and south from the south end.

Tanker Named for Indian Who Taught Petroleum Uses

Navy Tanker U.S.S. Soubarisson goes down the ways at the Marinship yard on San Francisco Bay. Launching ceremonies were part of the oil industry's 85th anniversary observance of the completion of the first U. S. oil well by Col. E. L. Drake at Titusville, Pa., in August, 1859. The tanker was named for Chief Soubarisson who ruled a peaceful tribe in Western New York in the early 17th century and taught white men the qualities of oil as it was then known in the North American wilderness. Inset is a closeup of the likeness of the chief painted on the vessel's bow

First Tankers Take Crude From Willamar Pipeline

Special to NPN

HOUSTON, TEX. — The new 34-mile pipeline of Pan American Pipe Line Co. is in operation carrying crude from the Willamar Field in Willacy County, Texas, to Port Isabel for subsequent movement to refining centers by water. The first tanker shipment has been made, Pan American has announced.

The line is approximately 3 miles in length and is of 8⅝-inch seamless steel pipe, solid welded, and protected from corrosion by an application of asphalt with bonded felt wrapping. A telephone line parallels the oil line.

The initial capacity is approximately 12,000 b/d. This can be increased to the estimated ultimate production capacity of the Willamar field by installation of additional pumping units at the pumping station in the field. Pumping equipment consists of reciprocating pumps and automotive type prime movers.

The line is served by an adequate gathering system and four field gathering stations covering the entire productive area. This is now approximately three miles wide and five miles long, with more than 50 wells producing at present, all flowing their allowable.

The completion of this line marks the establishment of a permanent and adequate outlet for the crude produced in the field, and eliminates the necessity of moving the oil by tank cars.

LIQUID GOLD

On August 27, 1859, the first drilled oil well in the world was brought in.

I am oil.
I am the rich, black blood of earth,
Surging through the soil for ages beyond measure.

I waited to be found.
I waited while the centuries slipped by
And Man still stumbled slowly overhead.

I was ready.
I held within me worlds of endless power
Undiscovered. Strength unknown...unwanted...
Till that historic day in Titusville,
Till that wondrous day in '59
When Man first opened earth
And worked to set me free.

Liquid Gold, they called me—
And as I gushed in roaring torrents upward,
Men fought and died to have me...
To channel me, enslave me to their ends.

But there were other men who saw in me
A greater promise...for all Mankind.

Men who glimpsed my power
And had the vision of the future in their dreams.

Yes, I have served Man well
These five and eighty years...
I have sent his motors racing over roads,
Churned his ships through seas,
Pushed his straining tractors across fields,
And lifted him above the earth
To soar unchallenged through the skies.

Today, my precious might is harnessed for
a greater cause.
Today the tanks of war, the trucks, the planes,
The very implements of Victory
Move forward on my strength.

Today, still greater reservoirs of power
Lie within me...waiting...ready.
And when the days of Peace return again,
I shall bring to Man
The rich, full promise of a better life...
I shall again unfold a vast new world to him.
I am oil...I am Liquid Gold!

Honoring the occasion of the 85th Anniversary of the drilling of the first oil well by Colonel Edwin L. Drake at Titusville, Pa., this tribute is published by Tide Water Associated Oil Company, one of the great pioneers of petroleum, and the first company to lay a pipe line from the oil fields of Pennsylvania to the coast.

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3 States Back Louisiana Fight Against Extra Gas Withdrawal

Special to NPN

BATON ROUGE, La.—Kansas, Arkansas, Mississippi and Texas will support Louisiana in a Federal Power Commission hearing Sept. 7 in Memphis on application of the Memphis Natural Gas Co. to increase withdrawals of Louisiana gas, according to Gov. Davis of Louisiana.

Gov. Davis said that Louisiana at the outset of the hearing will request a six-months' continuance in order to prepare more data on the gas fields from which the Memphis concern wants to take additional gas. Gov. Davis said that the original application proposed increased withdrawals from only the Monroe and Lisbon fields, but that an amended application has now been filed, accompanied by a contract with the United Gas Pipeline Co. "tantamount to United . . . guaranteeing to a great extent the gas supply to the Memphis firm."

The governor said the new request "places at issue the natural gas reserves of every gas field of any consequence in North Louisiana, including certain fields in East Texas, and conceivably every major field in the entire state of Louisiana."

Governor Stevenson of Texas referred Gov. Davis' request to the Texas Railroad Commission, which asked the attorney general's office to intervene in behalf of the state.

Chairman Beauford Jester said that Texas will contend that the authority or control over production of natural gas is a right of the states and not the federal government. It will also contend that Texas recognizes only the right of FPC to regulate transmission of natural gas across state lines when it moves in interstate commerce.

16 Louisiana Wells Completed

Special to NPN

BATON ROUGE, LA. — Louisiana completed 16 new wells with initial daily production totaling 4000 barrels in the week ending Aug. 26, the Minerals Division of the State Conservation Department has announced. Permits were issued for drilling 28 new wells.

Patman Calls Session of Small Business Committee To Tackle Peace Problems of Texas Operators

Special to NPN

AUSTIN—The House Small Business Committee will meet in Austin Sept. 20 to consider the problems Texas oil operators will face after the war, Rep. Patman (D., Tex.) announced here.

Rep. Patman, chairman of the nine-man committee, said his decision to hold the hearing was prompted by a warning from Ernest O. Thompson, member of the Texas Railroad Commission, to Texas oil men that they must prepare for the shock of reduced allowables.

The Texas Congressman, visiting the state capital, said he had read Col. Thompson's statement "with interest" and that he felt that his committee would be equally appreciative.

"We look upon Col. Thompson not only as the greatest oil authority in the country, but the greatest in the world," he said. "I am sure that my committee will see the advisability of meeting here with the oil industry of Texas immediately. Military successes abroad mean reconversion for oil men, particularly the small producers, so we are ready to tackle these problems."

Rep. Patman decided upon the Sept. 20 date for the committee meeting here since it follows by one day the statewide proration hearing, which will give the committee the advantage of one day's conversations with individual oil men from over the state. He requested that Col. Thompson draw up a suggested oil reconversion program for submission to the committee for study. Col. Thompson agreed to do this.

Production Nearly Doubled

Col. Thompson said that the fall of Ploesti should deprive Germany of her greatest source of oil and materially shorten the war, and at the same time it should have a bearing within a period of months upon the Allied oil supply.

"When the fighting ceases in Europe we will not need to send so much oil abroad," the former army colonel said. "In ordinary activity an army requires about one-half gallon of gasoline per soldier per day, as against two or more gallons per day when engaged in active combat or movements.

"We don't know the day when combat will cease in Europe. Therefore it is well for us to consider now the problem that will confront the oil producers when demand drops as it most surely will drop when peace comes."

Col. Thompson said that abandoning of rationing at home would help take up the slack of lost markets, but there would be less demand than now even if rationing were completely done away with.

"The oil producing plant in Texas consists of 101,501 producing oil wells. The allowable production set for Texas oil wells for September 1944 is 2,311,718 barrels per day.

"This compares with Texas oil production of 1,355,102 barrels per day in September, 1940, the year before our entering the war. The operators should prepare for the shock of reduced allowables."

Same Price, But Costs Are Up

Col. Thompson pointed out that "naturally" we will not be shipping oil to Rumania when that country has oil herself, and that if Rumanian oil fields can produce anywhere like they did in 1938, the last date figures were available, the Allies should be able to get some 49,200,000 barrels of oil from this source for European consumption.

"Our Army and Navy in the Pacific are knocking at the door of the Netherlands East Indies and will doubtless soon free them from Jap control. This will bring back to the Allies an additional oil production of 57,600,000 barrels annually . . .

"When it is remembered that the oil producer is selling his oil for pre-war price and his costs of operation, drilling and exploration have all gone up very decidedly, you can see that the little oil producer has been getting by only because of higher allowables. He has been selling his goods off his shelves for less than cost of reproduction, but he has been selling lots of it.

"Now with the prospect of reduced demand the little independent oil producer faces a real conversion problem."

Ask Check on Etex Figures Showing Pressure Decline

Special to NPN

AUSTIN — The Texas Railroad Commission is studying a five-point program suggested by operators in the East Texas field for testing the bottom-hole pressures in the big reservoir.

Some operators at the last statewide proration meeting expressed the belief that the decline noted the last two months in the field pressure may be attributed to faulty testing.

Meeting with the Commission's director of production, Jack Baumel, at Kilgore, the operators made these suggestions:

Increase the number of key (testing) wells to 100.

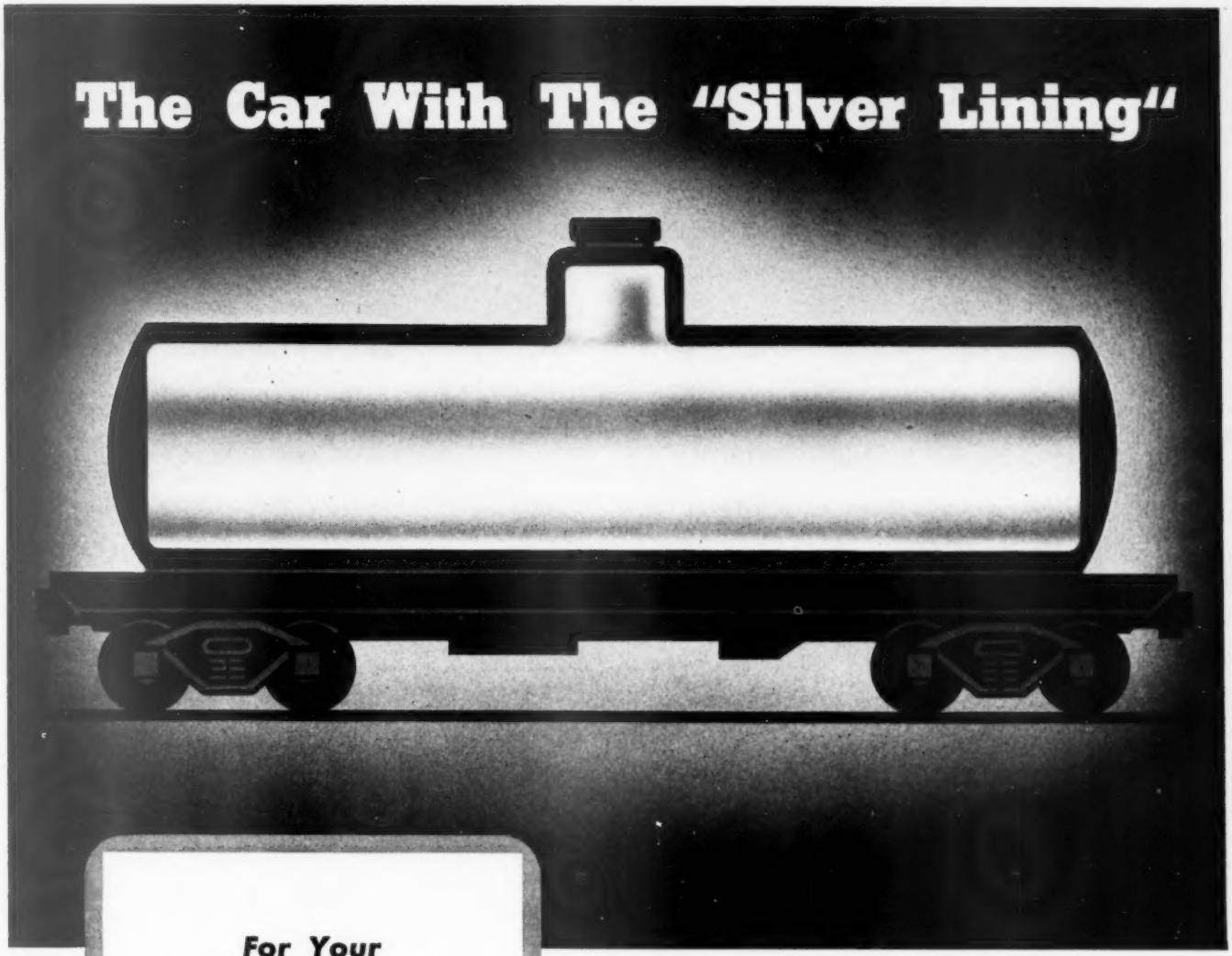
Determine monthly both a mathematical and weighted average.

Every quarter the Commission's 100 key wells shall be grouped with all wells and a weighted average determined as a check on the monthly pressure survey.

The Commission permit an operator to shut in a key well when necessary and that the key well's allowable be assigned ratably to other wells in the lease until the lease becomes marginal.

Company directors shall meet each month with the Commission to determine the accuracy of all bombs that will be used in quarterly tests.

The Car With The "Silver Lining"



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General American engineers are ready now to consult with you—to plan new tank cars with every feature needed to transport your products safely. Call or write our general offices — 135 South LaSalle St., Chicago 90, Ill.

GATX GENERAL AMERICAN

FOR hard-to-handle commodities, General American has built tank cars with special protective linings of nickel, stainless steel, rubber and lead.

Now here's a car with a "silver lining." It's a General American tank car of the future. The "silver lining" represents all the new specialized coatings you may need to carry your postwar products—and that General American will provide. You will have, then as now, definite advantages through use of General American cars for *safe, sure,* low-cost transportation.

GENERAL AMERICAN TRANSPORTATION CORPORATION

Builders and Operators of Specialized Railroad Freight Cars ★ Bulk Liquid Storage Terminals ★ Pressure Vessels and other Welded Equipment ★ Aerocoach Motor Coaches ★ Process Equipment of all kinds ★ Fruit and Vegetable Precooling Service

Sights Big Decrease In Texas Oil Demand

Special to NPN

AUSTIN, Tex.—Railroad Commissioner Ernest Thompson believes that, in view of the improved storage situation in Texas noted the week ended Sept. 2, the October demand for Texas oil may be lowered for the first time since the United States entered the war.

Col. Thompson said that Texas' above-the-ground storage increased 512,000 barrels during the week, the most for any week since the war. This shows production is meeting the full demand of war, he said, adding: "There are other evidences that we have hit our high."

By areas, he said the increases were: East Texas 333,000 barrels, West Texas 482,000, and Gulf Coast 131,000 for a total of 946,000. Storage in other areas dropped 434,000 barrels, bringing the overall down.

OPA Putting Final Touches on Stripper Advisory Setup

NPN News Bureau

WASHINGTON—Plans for setting up OPA industry advisory committees to help with administration of the stripper well subsidy program are being completed and letters of invitation to serve on committees are expected to go out to industry members within next week.

At present, OPA plans to set up one committee for each state affected by the stripper program, each committee consisting of about five industry representatives and a state government official, where possible, who would act in an unofficial capacity and probably be without voting power.

It is expected that more than one committee will be set up in states of Texas, Oklahoma, and possibly Kansas. It is also contemplated that one committee will serve for the entire Pennsylvania grade producing area, covering West Virginia, Pennsylvania, eastern Ohio, and southern New York.

OPA will consult with industry committees, after their establishment, on questions which may arise as to geographical limits of pools, extension of leases, and production from various horizons.

Echols Holdings Reported Sold for $4,350,000

Special to NPN

HOUSTON, Tex. — A veteran South Texas independent oil operator, George H. Echols, has disposed of around $4,350,000 worth of his holdings, according to announcement made here by his attorneys.

The deal not only includes the property in Echols' name, but the Titanic Oil Co., which was developed by Echols.

A Houston syndicate composed of Louis and Harry Pulaski, Morris Rauch and Floyd L. Karsten bought the Echols holdings in the League City field, Galveston County, the South China field in Jefferson County, the Hardin field in Liberty County, and the University field in Louisiana. No price was announced, but these properties include 18 producing wells with a daily allowable of 1,000 barrels.

H. L. Hunt, Dallas independent, and W. O. Woodard, Shreveport independent, bought Echols' holdings in the Jena, La., area which were opened for production by Echols a year ago.

O. R. Mitchell and J. F. Jarvis of San Antonio paid $3,400,000 for the Echols property in Ascension Parish, Louisiana.

The Stanolind Oil & Gas Co. bought a block of acreage in the Texas Rio Grande Valley near Donna; and W. H. Holland and Associates bought a block in Starr County.

Echols retained interests in the Napoleonville, Westwego, and Convent Dome Fields in coastal Louisiana.

Spacing Relaxed in Michigan

NPN News Bureau

WASHINGTON—This week increased the depth limit for oil wells drilled on 10-acre spacing from 1400 ft. to a new maximum of 1650 ft. in the Michigan counties of Allegan, Barry, Berrien, Branch, Calhoun, Cass, Kalamazoo, Kent, Muskegon, Ottawa, St. Joseph, and Van Buren with issuance of the amendment to Supp. Order 7 of PAO 11.

PAW pointed out that the amendment continues the requirement of a 20-acre unit for wells drilled between 1650 ft. and 2500 ft. Relaxation on 10-acre spacing will permit drilling of a limited number of additional wells in shallow pools that were previously regulated by the 20-acre spacing rule, PAW said.

Hearing Dates Fixed By Texas Commission

Special to NPN

AUSTIN—The Texas Railroad Commission has fixed dates for these special hearings:

Sept. 11—Hearing at Kilgore to determine whether an exception to Commission Rule 23 governing the East Texas Field should be granted to Magnolia Petroleum Co.'s J. W. Free "A" lease, G. W. Hooper survey, Upshur County.

Sept. 11—Hearing in Kilgore to determine whether an exception to Commission Rule 23 governing the East Texas Field should be granted to the Atlantic Refining Co. for leases in the Pru and Sanchez surveys in Rusk and Gregg Counties.

Sept. 12—Hearing in Austin on application of Fred W. Wood to complete dually his State No. 2 well in the Rooke Field, Refugio County.

Sept. 12—Hearing in Austin on the application of Union Producing Co. to complete dually its Youngblood-Roe No. 1, Hull A-2 Well in the Carthage Field, Panola County.

Sept. 12—Hearing in Austin on the application of Republican Natural Gas Co. to complete dually its Rachal No. 49 well in the East White Point Field, Jackson County.

Sept. 12—Hearing in Austin on the application of Louis Crouch to complete dually his No. 2 Meinert Well in the Mayo Field, Jackson County.

Sept. 12—Hearing in Austin on the application of L. T. Burns for a new pool allowable of special allowable on his Nick Brooks No. 1 well in Young County.

Kansas, Okla. Crude Prices Spelled Out

NPN News Bureau

WASHINGTON—In line with recent suggestion to industry in Kansas and Oklahoma that ceiling prices for crude of specific gravities below 28 degrees be spelled out dollars-and-cents-wise, formal action along these lines by OPA is expected to be taken within next week or so.

OPA's spell-out would set following specific ceiling prices: Below 20 degrees, 83 cts per bbl.; 20-20.9, 85 cts; 21-21.9, 87 cts; 22-22.9, 89 cts; 23-23.9, 91 cts; 24-24.9, 93 cts; 25-25.9, 95 cts; 26-26.9, 97 cts; 27-27.9, 99 cts; 28-28.9, $1.01; 29-29.9, $1.03; 30-30.9, $1.05; 31-31.9, $1.07; 32-32.9, $1.09; 33-33.9, $1.11; 34-34.9, $1.13; 35-35.9, $1.15; 36-36.9, $1.17; 37-37.9, $1.19; 38-38.9, $1.21; 39-39.9, $1.23, and 40 degrees and above, $1.25.

It is expected by OPA that this scale will not reduce prices. However, exceptions to scale are expected to be made in special cases.

Prompted by DSC Ruling

Establishment of ceiling prices for specific gravities below 28 degrees was made necessary by ruling of DSC that if purchasers buying crude from stripper wells granted premium payments pay less than ceiling price, their reimbursements from government for extra premium paid would be reduced by difference between ceiling price and price purchaser pays.

In Kansas and Oklahoma, OPA ceiling prices for crude were spelled out only down as far as 28 degrees. The ceiling for 28 degrees was $1.01, which also applied to gravities below. Inasmuch as some purchasers were buying crude with gravity below 28 degrees, and paying less than $1.01, they faced cutback by DSC, as pointed out above, if they were buying from area granted stripper well premium payment.

Dallas Reserve Bank Reports More Drilling in District

Special to NPN

DALLAS, Tex.—A marked increase in drilling in the Eleventh Federal Reserve district for the first seven months of 1944 compared to last year has been noted in the monthly review of the Federal Reserve Bank of Dallas.

According to the report, approximately 3700 wells have been completed so far this year compared with 2400 in the same period last year. This district includes all of Texas and parts of Louisiana, Arkansas, Oklahoma, New Mexico and Arizona.

According to the report, there were 1002 wildcat wells drilled this year but 78% of these failed to produce oil in paying quantities.

The report credited an improvement in the supply of drilling rigs and equipment, the relaxing of certain government restrictions, increased wildcatting, and the stripper subsidy for the increased activity.

EMPLOYER'S ROLE

(*Continued from p.* 24)

will be hand-picked and hand-fashioned for the job by experts instead of by luck or unguided training. The men who are placed in such industry for training will be placed there, of course, on approval, and they will be trained for specific occupations in a plant or business. Standards will be set up, but these industries which participate in this program of rehabilitation will, I am sure, be glad to meet these standards.

In considering the general readjustment of the returning servicemen, we should bear in mind certain facts concerning them. The men in our armed forces are among the healthiest and most normal of our American manhood. Their educational level is high; 14% of the Army of the World War II are college men; 53% have some high school education, and of these, almost one-half are graduates. Only a third of the men are in the grade school level, as compared with 80% in the last war.

The men in our armed forces are young men. In 1943, 53% in the Army were under 25 years of age; 80% were under 30. Consequently, the great majority of the veterans will still be in their 20's when they return to civilian life. At least a third of them will have had no vocational experience except that acquired in the armed forces. This is due to the fact that this number entered the armed forces directly out of school. Only about 20% were out of school more than three years before they were inducted, and large numbers of these had not acquired a permanent employment status at the time they entered the Army or the Navy. A majority, therefore, will have had, at the most, only one or two short work experiences. However, this lack of civilian vocational training will be counterbalanced by the vast amount of technical training these men have received while in service.

Face Difficult Problem

From such men as these will come the handicapped veterans. If we may judge by the experience with the 125,000 disabled veterans placed after the last war by the Veterans' Administration, they will be characterized by an intense desire to fit themselves into suitable employment and will gladly undergo the necessary training for the attainment of their occupational objectives.

The problem of finding suitable employment for the handicapped will be a difficult one. In the last two or three years, however, employers all over the country have had opportunities to try out various kinds of handicapped workers. Some of these have been returned veterans; others have been handicapped civilian workers. These handicapped workers, both veterans and nonveterans, have had opportunity to show what they can do, and most of them have demonstrated beyond any question of a doubt the fact that, if properly placed, they can render very important service of many different kinds.

A few years ago it was thought that they would add to the difficulties of the employer; that there would be a high rate of absenteeism; that they would not carry their share of the load; that they

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PT Boat—the very name symbolizes speed and daring! Here, where operations are timed to the second—where minutes mean most—MILVACO valves and fittings are saving precious time in feeding the fuel that sends Uncle Sam's mosquito fleet of Patrol-Torpedo boats into action.

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THE GMC "DUCK"

LEADING LADY OF ALLIED LANDINGS

Says Ernie Pyle,

Scripps-Howard War Correspondent

WITH FIFTH ARMY BEACHHEAD FORCES IN ITALY, April 19—(By Wireless)—Probably the two outstanding features of our handling of supplies on this Fifth Army beachhead have been the "duck," or amphibious truck, and our system of carrying regular trucks fully loaded aboard many ships so they can be driven right off when they reach here.
Without the "ducks," some of our invasion landings would have been pretty close to impossible. It is a leading lady in this drama we have.
All day long you see a thin, black line of tiny boats moving back and forth between shore and ships at anchor a mile or two out. They remind you of ants at work. These are "ducks," going constantly back and forth all the time, day and night. There are hundreds of them.
ONE day I stood on the beach and hooked a ride on one of them. A duck has no crew except the

Based on a News photo showing GMC "Ducks" carrying supplies to the Allies' Anzio beachhead.

INVEST IN VICTORY . . . BUY MORE WAR BONDS

Ernie Pyle, Pulitzer Prize winner for war reporting, is only one of many war correspondents to praise the outstanding performance of the GMC Truck & Coach "Duck."

The "Duck" is a leading Lady of Allied landings because its amazing amphibious ability enables it to perform many tasks that can be duplicated by no other vehicle. It has carried men, munitions and materials from ship to shore to inland fighting areas. It has charted invasion shores the night before "D" day. It has hauled howitzers from freighter to firing position. It has rescued disabled landing craft. It has blasted enemy beaches with barrages from multi-mounted rocket guns. It has served as a radio broadcaster, land and water ambulance, command car and mobile fueling station.

And in France, this versatile GMC amphibious truck again played a leading role in the invasion of Fortress Europe.

GMC TRUCK & COACH DIVISION

GENERAL MOTORS

HOME OF COMMERCIAL GMC TRUCKS AND GM COACHES . . . VOLUME PRODUCER OF GMC ARMY TRUCKS AND AMPHIBIAN "DUCKS"

would not reach production standards; and that they would show a higher rate for accidents. None of these things has proved true. Recent studies indicate that the accident rate is generally lower among the handicapped workers than among the normal workers.

Industry has already put itself on record with respect to the efficiency of the handicapped. Companies which were first moved by altruism found that they themselves were the beneficiaries in hiring handicapped individuals.

Many of our large corporations have had for many years well-defined policies and programs relating to the employment of the physically handicapped. The Ford Motor Co., according to recent estimates, employs over 11,00 persons having some form of physical disability. Of these 1200 are blind. In one of its large factories, about 10% of the men employed are handicapped in some way. On Nov. 19, 1943, the officials of General Motors Corp. addressed a communication to all of its general managers and personnel directors. The subject of the communication was "Rehabilitation of Employes Returning from Military Service". In the letter of transmittal and the instructions to its managers and personnel directors, several significant statements are made, a few of which are quoted below:

Favors Liberal Policy

"More than 82,000 General Motors employes are in military service and more are going every day. Already, some of these men are returning to work in the plants after recovering from injuries received while in active service. The problems of placing disabled veterans will become increasingly serious and important throughout the period of the war and afterwards. We feel that it is not too early to make preparations to meet this situation."

"We should be liberal in our policy in rehabilitating our employes returning from service and we should make every reasonable effort to assist them in readjusting themselves to normal plant activity. Experience has demonstrated that the handling of the more difficult cases requires unlimited patience and a high degree of ingenuity, factors which should be weighed in selecting the personnel to follow through on the program."

The Bethlehem Steel Co. reports that it has already employed more than 9000 veterans of World War II. Of this number, approximately 4000 were former employes of the company who were reemployed after they returned from service, and 5000 were veterans who had never worked for this company before.

The Caterpillar Tractor Corp. of Peoria, Ill., has developed a program for the utilization of handicapped workers which has attracted wide attention.

New Program for Handicapped

The problem of placing disabled veterans will become increasingly important and serious as the war goes on. We feel that it is not too early to make preparations to meet this situation. Management today seems to be agreed that every possible effort should be made to reemploy and place handicapped servicemen on jobs which they can perform successfully without danger to themselves or to fellow workers. They must be placed on jobs which they can do productively and with the greatest financial return to

*Keep your extinguishers in shape... FREE BOOK tells how!

When fire breaks out, there's no time to repair or recharge extinguishers — they must be ready to hit the blaze fast! So the logical time to keep the equipment in fighting form is *before* the emergency . . . by systematic inspections at fixed intervals.

A method for setting up an extinguisher maintenance system in your organization is outlined in a booklet prepared by Walter Kidde & Company. It covers *all* types of equipment, tells exactly what to check on each type, how often to examine and recharge. It shows how extinguishers should be placed and marked, how records should be kept. This book "Inspection and Maintenance of First Aid Fire Extinguishers", will be sent you upon request. Write for your copy.

WALTER KIDDE & COMPANY INC., 140 CEDAR ST., NEW YORK 6, N. Y.

themselves. This means that they must do "necessary jobs". Any attempt to make a job for a handicapped man will not work out satisfactorily for the man or for the company. This, of course, does not preclude the possible re-arrangement of a job and a reasonable period of readjustment for the man himself.

Careful Surveys Made

When a handicapped man is placed successfully, he ceases to be handicapped from the standpoint of his productive ability and his earnings. There will be many employes released from the armed forces for physical reasons whose handicaps will in no way interfere with their return to their former jobs. Such cases will present no problems and will be simple to handle. There will be other cases of more serious physical handicaps which will require rehabilitation before the man can be put to work.

Many industrial organizations have already made careful surveys in order to determine the various kinds of work to which men with physical handicaps can be adjusted. After handicapped veterans have been assigned to positions, it will be necessary for the medical authorities and the personnel department to follow up the cases to see that the handicapped veterans are placed in jobs which are in keeping with the report and recommendation of the physician of the company. It will be highly desirable to follow up the progress of handicapped veterans after they are placed, in order that any adjustment necessary may be made even if such should require the transfer of workers from one department to another or even from one plant to another.

The physicians making the examinations of handicapped veterans should outline in detail the conditions which they discover that make the employe unsuited for certain types of work, and full information should be furnished as to what type of work should be avoided in assigning the handicapped person to employment.

For instance, there will be persons who should not work near fast-moving machinery; there will be others who should not do any heavy lifting; there will be still others who should work on the ground level only and not be allowed on ladders, scaffolds, or elevated platforms; and there will be some who must avoid dust, fumes, or skin irritants. Some will find it impossible to walk or stand for considerable periods of time in connection with their work.

The doctor and personnel director will, on some occasions, find returning servicemen who will be unable to perform any work which they have available at a certain time, but these persons will be more in need of assistance than those who have no serious disabilities. Their mental attitudes will be important and their morale must be bolstered in every way possible. It is not enough to say to a former employe, or to a veteran who has not worked for a certain company previously, that because he has a serious disability, he cannot be restored either to his old job or hired for a new position. Every effort should be made to employ him or to give him constructive suggestions as to where he can probably find work.

After the veterans have completed various types of education, rehabilitation, and specialized training courses, they will be seeking employment. Millions of the returning servicemen will desire employment as soon as they are released from service. In studying the general problem of employment for veterans, serious thought should be given to the fact that approximately one-third of the men now in the armed forces have never had permanent employment.

Under Section 8 of the Selective Training and Service Act of 1940, as amended, the Selective Service System is charged with a dual responsibility to returning veterans:

1. To render assistance in restoring them to their former jobs;
2. To render aid in securing new positions for those who do not choose to, or cannot, be reinstated in their former positions, and for those who had no permanent employment at the time they entered the military service.

Veterans entitled to aid include all persons, male and female, who, subsequent to May 1, 1940, entered upon active service in the Army, Navy, Marine Corps or Coast Guard, whether by induction, enlistment, commission or otherwise, and who have satisfactorily completed any period of active duty or period of training and service under the Selective Training and Service Act of 1940, as amended.

Personnel Division Set Up

The Director of Selective Service, to facilitate the discharge of his responsibilities in regard to employment and re-employment of veterans, has established a Veterans' Personnel Division (formerly Re-employment Division) at national headquarters of the Selective Service System.

The State Director of Selective Service, as authorized by the Governor, has the obligation and responsibility of organizing and supervising the program within his state. It is the responsibility of the local boards to discharge such obligations at the local level. All of the facilities of the local boards are available for the re-employment program.

Attached to each of the local boards are one or more re-employment committeemen who serve as the friends and advisors of the veterans. These re-employment committeemen, working in cooperation with the local boards, will render any kind of employment and other assistance possible. The services of the Veterans' Employment Service of the U. S. Employment Service, War Manpower Commission, will be utilized especially in finding new work opportunities for the veterans.

A veteran is entitled by law to reinstatement in his former position or to a position of like seniority, status and pay, if the following conditions exist:

"1. If such a position was in the employ of a private employer, the United States Government, its territories or possessions, or the District of Columbia;
2. If such position was not a temporary position;
3. If he left such position subsequent to May 1, 1940, in order to enter upon active military or naval service in the land or naval forces of the United States;
4. If he satisfactorily completed his period of training and service and received a certificate to that effect;
5. If he is still qualified to perform the duties of such position;
6. If he makes application for re-employment within 40 days after he is relieved from service;
7. If such position is in the employ

Laws Which Relate to Employment of Veterans

1—Selective Training and Service Act of 1940, with amendments.

This law sets forth the conditions under which a veteran is entitled to reinstatement in his former position, or position of like seniority, status and pay. It provides for U. S. District Courts to empower employers to comply with the provisions of the act, and to compensate for loss of wages and benefits in case of failure.

2—Serviceman's Readjustment Act of 1944, "G.I. Bill of Rights".

In addition to guaranteeing loans to veterans for the purpose of establishing themselves in business, full-time and part-time vocational training is provided. A Veterans Placement Service Board is set up to determine matters of policy and promote interest among employers in finding most suitable work for veterans.

3—Veterans Administration Act, as amended in 1943.

Provides for maintenance and support of veterans during vocational rehabilitation and for supervision of amounts of payments by employer-trainers during training on the job.

4—Federal Security Agency Act, as amended in 1943.

Sets up a program for the Rehabilitation Division of the Federal Security Agency, through state boards, for the rehabilitation and training of non-veterans in need of rehabilitation; and of veterans who do not have service-connected disabilities or for various reasons may not take advantage of the rehabilitation program of the Veterans Administration.

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HUMBLE OIL & REFINING COMPANY

of a private employer, the employer's circumstances have not so changed as to make it impossible or unreasonable to reinstate the veteran to such position or to a position of like seniority, status and pay."

A veteran who is restored to a position in the employ of the Federal Government or a private employer is entitled to the following additional benefits:

a. He shall be considered as having been on furlough or leave of absence during his period of service.
b. He shall be restored without loss of seniority.
c. He shall be entitled to participate in insurance or other benefits offered by the employer pursuant to established rules and practices relating to employes on furlough or leave of absence in effect with the employer at the time such person entered military or naval service.
d. He shall not be discharged from such position without cause within one year after such restoration.

When a veteran is not eligible for, or does not wish to be restored to his former position, but desires a new position in private industry, he should be referred to the Veterans' Employment Service, U. S. Employment Service, for assistance in securing a new position. Many veterans, upon their return, will be unable to fill their old jobs or any other job. They may be battle casualties; they may have service-connected or nonservice-connected disabilities; they may require rehabilitation, hospitalization, prosthetic appliances or other forms of physical care; or they may have financial problems involving benefits and allowances. Under such circumstances, the veteran should seek the assistance of the Veterans' Administration or the assistance of the Vocational Rehabilitation Division of the Federal Security Agency.

Employers Eager to Help

It is encouraging to observe that, of the thousands of veterans already released from active service, practically all those entitled to reemployment in their old jobs and desiring such reinstatement have been reinstated without delay. Employers generally have made liberal interpretations of the Act and have done everything possible to carry out their obligations. Where veterans, for various reasons, could not be reinstated in their old jobs, employers have made every effort to adjust them to other jobs in their plants or to help them find other work opportunities.

Employers in many instances have said they hoped to carry out not only the legal obligations of reinstating returning veterans in their old jobs, but also the moral obligations implied in the law. Such policies, followed by large and small employers, will do much to stabilize employment and to give the veterans a feeling of security following the war. It is to be hoped that employers will re-employ returning veterans with the same enthusiasm as they have displayed their service flags.

Organized labor has been equally cooperative in helping adjust problems of seniority, wages, union dues and other factors involved in restoring veterans to their former employment and assisting them in securing new work opportunities. There is every reason to believe that this same fine co-operative spirit will continue in the postwar period.

Educational Advantages

Education and training opportunities should attract large numbers of veterans. Some of the state legislatures have passed laws giving free tuition and granting other concessions to the veterans of their States.

The recently passed Servicemen's Readjustment Act of 1944 "G.I. Bill of Rights" became a law on June 22 and covers a wide range of benefits for veterans. In signing the bill, President Roosevelt remarked that the law gave "emphatic notice to the men and women in our armed forces that the American people did not intend to let them down."

The general provisions of the Servicemen's Readjustment Act are:

(1) It authorizes for veterans up to 52 weeks of unemployment compensation at the rate of $20 a week, with adjusted compensation for self-employed veterans restoring themselves in business rather than seeking jobs from others.

(2) It guarantees 50% of loans up to $2000 to veterans at interest of not more than 4% for the purpose of establishing homes or businesses, or purchasing farms.

(3) It appropriates $500,000,000 for construction of additional veterans' facilities, including hospitals, and strengthens provisions to assist veterans in finding employment through the U. S. Employment Service.

(4) It authorizes allowances for as much as four years of education or training in certain cases, with tuition and fees amounting to not more than $500, for an average school year, plus monthly subsistence pay of $50 for a single veteran and $75 for those with dependents. The amount of education any veteran may receive will depend upon his length of service in the armed forces.

Those eligible for the several benefits are those men and women who served in the military or naval forces (Army, Navy, Marine Corps or Coast Guard) of the United States between Sept. 16, 1940, and the termination of the present war; were discharged or relieved from active service under conditions other than dishonorable, and who were on active duty 90 days or more or were discharged or released from active service by reason of an actual service-incurred disability.

(An article is in preparation for National Petroleum News discussing the possibilities for returning service men engaging in business in the oil industry, under the provisions of the Servicemen's Readjustment Act.)

Tide Water Set for Mass Use Of One-Quart Fiber Cans

NPN News Bureau

NEW YORK—A "revolutionary" new one-quart container, made of fiber heavily reinforced with an oil-proof plastic lining, was announced last week by Tide Water Associated Oil Co., which is using the new container for distribution of its lubricating oil. This development arose from the acute wartime shortage of metal containers. It was reported that Tide Water is the first of the big oil companies to achieve mass distribution in fiber cans.

The container is of spiral construction, and is lined and sealed top and bottom with a new oil-resisting plastic. It is manufactured on special machines developed for the purpose by the company in co-operation with Fiber Can Machinery Co. Because of the spiral structure, a spiral form of labeling in full colors was devised which gives excellent display effects.

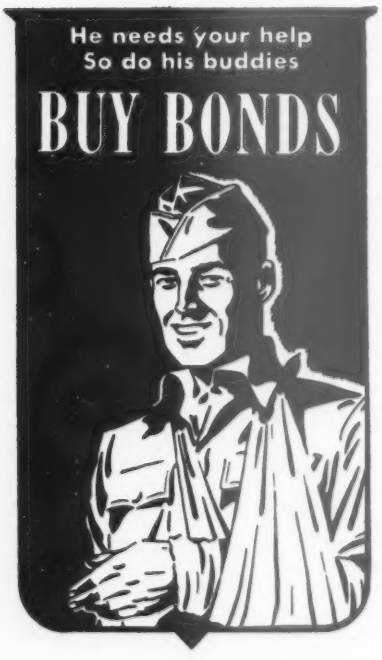
The use of the new container for the present will be confined to Veedol Motor Oil in eastern and Mid-Continent States.

N.P.A. Meeting Cancelled

The forty-second annual meeting of the National Petroleum Assn., scheduled for Atlantic City on Sept. 20 and 21st, has been cancelled.

Fayette B. Dow, General Counsel, in making this announcement said that the trustees unanimously voted to postpone the annual meeting owing to travel conditions, and in response to urgent government requests to reduce the demands on passenger transportation.

There will be a meeting by the Board of Trustees at the William Penn Hotel, Pittsburgh, at 11 a. m. Sept. 29, Mr. Dow announced.



to support their bravery and skill that will win the Peace.

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Fear is what does it,
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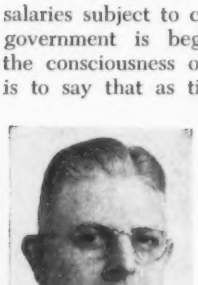
PROVED IN 50 BILLION MILES OF
It's Phillips Finest Quality
We used to ride a lot
50 BILLION MILES OF SERVICE
...speak no evil!
"There is only one evil"
PROVED IN 50 BILLION MILES OF SERVICE

Part of the current fall change-over campaign on Phillips 66 Motor Oil regularly appearing in 510 newspapers.

COMPLIANCE SERVICE ON WAR OIL RE

Beginning First of Series on Questions Raised On Wage and Salary Stabilization Requirements

The burden of having wages and salaries subject to control of the Federal government is beginning to sink into the consciousness of businessmen. That is to say that as time passes more and more operators of free enterprises feel the pinch of having the control of employes earnings taken out of their hands.



Mr. Hadlick

The decision to devote several articles to wage stabilization stems principally from a letter received from a reader. He writes "In the past four or five months I have been going through quite a turmoil in getting our wage stabilization matters cleared up here. After some effort, I finally found an attorney who made a specialty of wage stabilization laws and during one of our conferences I hazarded the statement that probably 80% of small business concerns have violated this law. He said, 'Why do you limit your statement to small business concerns?' "

Wage stabilization is merely a rule by which government tells business that wages and salaries are frozen as of a particular date. To make that basic rule understandable Government goes further and says that no increases or decreases can be made in wages and salaries as of the specified date except with permission (wage decreases will not be discussed in these articles).

General Order Authorized

We are going to reduce hundreds of pages of rules, regulations, interpretations, forms, etc., into reasonably simple language, and to boil that language down to as few as possible of these weekly articles. No attempt can be made to get to the very specific problem of every reader. On the other hand, the effort is being made to become specific enough so that those who do read these articles may get an idea that they do or do not need to give consideration to the problem.

The basis of control starts with the Wage Stabilization Act of Oct. 2, 1942, a short document in which Congress authorized and directed the President to issue general order stabilizing prices, wages, and salaries which affect the cost of living, and to stabilize them on the basis of levels which existed on Sept. 15, 1942. The Congressional reason for the law is the simple statement that it is necessary to aid in the effective prosecution of the war.

It isn't necessary to give any further time to consideration of the Congressional authority for what has been and still is going on, except in the matter of penalties. The penalty provision states that upon conviction for a violation the fine shall be not more than $1000 or the imprisonment shall be for not more than one year, but a violator can be subjected to both fine and imprisonment. There is another very serious and frequently overlooked provision in the law. This says that the President shall prescribe the extent to which any wage or salary payment made in contravention of the regulations shall be disregarded by the executive departments and other government agencies in determining the costs or expenses of any employer for the purposes of any other law or regulation. That's just a polite way of laying

Operation of the various laws, rules and orders concerned with operation of wage and salary stabilization is discussed in the accompanying article by Elwin E. Hadlick, 25th of his series on war-oil compliance. This is a subject which is becoming burdensome to many operators in the industry and in subsequent articles Mr. Hadlick plans to answer a number of questions that have been raised concerning it.

the foundation for the directions which will be dealt with later in these articles, those directions for example by which the entire amount paid to an employe (not just the amount in excess of the approved rate) is removed from the taxpayer's tax return as a deductible expense item. Taken all together the penalties are severe.

"Hold-the-Line" Order

The Wage Stabilization Act was followed by the quite well known wage stabilization order of the President, Executive Order No. 9250. This needs to be given no partcular attention except to note that it is the order by which the President established the job of Economic Stabilization Director with only one policy, that policy to be to stabilize the cost of living in accordance with the Wage Stabilization Act. The balance of the subject matter of the order comes up more naturally and in more complete detail later on when the regulations are considered.

That wage stabilization order was followed by the President's famous "Hold-the-Line" order. This is the order in which the Chief Executive directed that there should be no further increases in wages or salaries except such as are clearly necessary to correct sub-standards of living. With a flourishing bow the order did permit increases within the limits of the Little Steel Formula (15% over the level of January 1941), but even these were made subject to approval before being put into effect. Of necessity the order further permitted reasonable adjustments of wages and salaries in cases of promotions, reclassifications, merit increases, incentive wages or the like, but on conditions which will be mentioned.

In issuing the "Hold-the-Line" order the President started right in by saying "to hold the line we cannot tolerate further increases in prices affecting the cost of living or further increases in general wage or salary rates except where clearly necessary to correct substandard living conditions. The only way to hold the line is to stop trying to find justifications for not holding it here or not holding it there." That ought to make it quite clear that there isn't any fooling on this subject.

The Director's Orders

Next in order come the regulations of the Economic Stabilization Director, issued pursuant to authority given him as outlined. In this set of rules there begin to appear definitions of terms, specific rules, amplification of wage policies, etc. It is a basic document of some length, but simply written and amazingly short for the number of rules which are laid down.

These regulations of the Economic Stabilization Director will require some space for analysis. The only part that can be covered in this article is a partial answer to that question which is asked so much—"Am I covered?". Some of the readers can get off right here, for they have no need to further read these articles if they have eight or less employes under conditions set forth. That specification of the number of employes must be carefully watched; in some other laws the rule is that coverage is of those who have eight or more employes, and in the business world that expression is quite well understood. Someone either slipped or purposely confused the issue by adopting the phraseology that the limitations on wage and salary adjustments "apply only in the case of an employer who employs more that eight individuals".

Those simple words are subject to some tricky exceptions, and likewise they are so surrounded by other rules and regulations that employers are for all practical purposes prevented from using

fancy arithmetic to bring themselves outside the scope of the rules. Keep in mind that we are speaking in these articles only of the petroleum industry, and any expressions used are limited to that industry; the rule can be different in other industries.

In counting his employes an employer must count all who work in all of his establishments; an employer may not consider each establishment as a separate unit. Having counted, and finding that he has eight or less employes, an employer can be sure that he is not subject to wage and salary stabilization unless his wages, hours or working conditions have been established or negotiated by a contract on an area, industry or some similar basis.

In counting employes it is not necessary to count partners in a partnership nor corporation directors who serve without regular duties and without pay. The determination must be made at the time of the adjustment; in other words it is possible for an employer with eight or less employes to make an adjustment without approval, even though he once had or later has a larger number.

Such a transaction is subject to scrutiny; it isn't advisable to proceed in these borderline cases without clearance from the authorities.

Index of Week's War-Oil Orders

(Issued August 26-September 2, 1944)

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PAO 23—Limitation on shipment of residual fuel oil from Far Western states.

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GMPR, SR 11, Am. 53—Conversion of raw materials into aviation gasoline and its components exempt from price control.

GMPR, Am. 64—Modification of maximum prices by supplementary regulation.

GMPR, Order 83 under §1499.18(c)—15c per bbl. replaces 7 mills per net ton mile as barge rate for Louisiana bayou and bay transportation.

Second Revised Max. Export Price Reg., Am. 9—Increase of export price for exporters entitled to domestic sales subsidy

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Ruling on Specification of Maximum Bunker Fuel on Certificates for Operation of Vessels—WSA representative must approve amount of bunker fuel allowed for each voyage.

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Correspondence between WPB general counsel and Attorney General—Relation of anti-trust laws to reconversion planning.

CODE: AO—Administrative Order; CMP—Controlled Materials Plan: D—Directive; FDO—Food Distribution Order: GMPR—General Maximum Price Regulation: GO—General Order: Interp.—Interpretation; L—Limitation Order; M—Conservation Order; MPR—Maximum Price Regulation; P—Preference Rating Order: PAO—Petroleum Administrative Order: Pri. Reg.—Priorities Regulation: Proc. Reg.—Procedural Regulation: PS—Price Schedule; RO—Ration Order; RPS—Revised Price Schedule; SO—Supplementary Order; SR—Supplementary Regulation.

Digest of Week's War-Oil Orders

Petroleum Administration for War

NORTH AND WEST CENTRAL TEXAS REMOVED FROM SO 8's JURISDICTION—PAO 11, SO 8, Am. 1—SO 8's territory now limited to parts of Oklahoma and Kansas. Issued 8-25.

USE OF MATERIAL IN NORTH AND WEST CENTRAL TEXAS WELL DRILLING—PAO 11, SO 14—Well-spacing rules in 42 counties in north and west central Texas (formerly under SO 8) modified to permit simultaneous development of overlying oil pools. Spacing governed by depth of productive formation to which wells are to be drilled, and number of permitted depth ranges are specified, without regard to depth of other wells. Wells of 1400 ft. or less take 5-acre spacing; 1400-2500 ft. 10-acre; 2500-3400 ft. 20-acre; over 3400 ft. 40-acre. State authorities to determine required distance between wells and distance from property lines. Issued 8-25, effective 9-15.

LIMITATION ON SHIPMENT OF RESIDUAL FUEL OIL FROM FAR WESTERN STATES—PAO 23—See article p. 14, Aug. 30 issue NPN. Issued 8-25, effective 9-15.

Office of Price Administration

CONVERSION OF RAW MATERIALS INTO AVIATION GASOLINE AND ITS COMPONENTS EXEMPT FROM PRICE CONTROL—GMPR, RSR 11, Am. 53—Issued 9-1, effective 9-6.

MODIFICATION OF MAXIMUM PRICES BY SUPPLEMENTARY REGULATION—GMPR, Am. 64—GMPR ceilings for commodities or services may be modified by supplementary regulation. Issued 8-19, effective 8-24.

15c PER BBL. REPLACES 7 MILLS PER NET TON MILE AS BARGE RATE FOR LOUISIANA BAYOU AND BAY TRANSPORTATION—GMPR, Order 83 under §1499.18(c), as amended—Hazardous conditions of transportation occasioned this increase of from approximately 8¾c per bbl. to 15c, for transportation of petroleum and products by barge from Bayou des Glaises, La., through various bayous, bays, and other channels to Standard Oil plant at North Baton Rouge, La. Issued and effective 8-26.

INCREASE OF EXPORT PRICE FOR EXPORTERS ENTITLED TO DOMESTIC SALES SUBSIDY—2nd Rev. Max. Export Price Reg.—Such exporters may either take as their base price the one expressly provided therefor in the applicable domestic price regulation, or if none so provided, may increase base given in MEPR by amount of subsidy. Issued 8-11, effective 8-16.

GASOLINE AND FUEL OIL BULK PRICE CHANGES—MPR 88, Am. 17—See article p. 3, Aug. 30 NPN. Issued 8-28, effective 9-1.

INCREASES AND REDUCTIONS IN EASTERN SEABOARD RETAIL GASOLINE AND FUEL OIL PRICES—MPR 137, Am. 5—See page 3, Aug. 30 NPN. Issued 8-28, effective 9-10.

FINAL PRICING METHOD FOR LUBE OILS CLARIFIED—MPR 510, Am. 3—See article this issue NPN. Issued 8-31, effective 9-5.

STOVE DEALER REGISTRATIONS AND RECORDS; CERTIFICATE ENDORSEMENTS—RO 9A, Am. 13—Dealers and distributors registering late must file detailed inventory records with OPA. Those already registered may correct inaccuracies by filing with Board, for forwarding to District Director, 3 copies of corrected registration on OPA Form R-902. Director may approve application and direct Board to issue inventory certificates due by reason of correction only if filed by 11-30-44, or within 90 days of registration for those registering after 9-1-44. Detailed inventory and transfer records must be kept. Consumers and dealers must endorse certificates before use, but those mailed in without endorsement may be endorsed by recipient if shipment has already been made to customer. Issued 8-28, effective 9-1.

NEW AND RENEWAL APPLICATIONS FOR HEAT AND HOT WATER RATIONS—Rev. RO 11, Am. 24—See article in this issue NPN. Issued 8-30, effective 9-1.

War Production Board

CONSTRUCTION RESTRICTIONS — L-41, as am. 8-19-44—Central steam heating connections added to those for which it may be necessary to obtain WPB approval. Issued 8-19.

INSTALLATION OF PROCESSING MACHINERY—L-41, Revoc. Interp. 8—These instructions now incorporated in amended Direction 2; **see below.** Issued 8-19.

INSTALLATION OF MACHINERY AND EQUIPMENT RATED ON FORMS WPB-541 AND 542—L-41, Interp. 10—WPB permission must be obtained to make installations even though machinery is rated on WPB-541 or 542 if not within L-41 exemption or permitted under Direction 2. Issued 8-19.

INSTALLATION OR RELOCATION OF MACHINERY AND EQUIPMENT—L-41, Direction 2 as am. 8-19-44—WPB permission unnecessary for installation of single piece or group

of related pieces of processing machinery (new or used), or machinery specifically authorized on a special form (including WPB-541 and 542), including the building alterations necessary therefor, if installation cost not over $5,000 and total cost of machinery and installation not over $25,000. No new building may be included. Reinstallation in same plant permitted, as well as in another plant of same owner. WPB permission also unnecessary for relocation of machinery previously used in a plant if no alterations required and relocation materials for each piece do not exceed $500. Issued 8-19.

LIQUEFIED PETROLEUM GAS EQUIPMENT RESTRICTIONS—L-86, as am. 8-26-44—Application for construction, remodeling to be made to PAW on Form 30, as outlined in article on p. 50, Aug. 30 NPN. Issued 8-26.

PLACEMENT OF ORDERS FOR LIQUEFIED PETROLEUM GAS TANKS—L-86, Direction 1 as am. 8-26—Preference ratings granted on Forms WPB-541 and WPB-547 **may not** be used to purchase L.P.G. tanks. Only WPB-809 or GA-855 are valid, and original authorization, accompanied by certified purchase order, must be presented to tank manufacturer. Issued 8-26.

PAO 11 HAS SUPERSEDED M-68—M-68 and M-68-1 through M-68-6 formally revoked, to coincide with actual practice in effect ever since PAO 11 was issued to govern use of materials in production operations. Issued 8-26.

PAO 12 HAS COMPLETELY SUPERSEDED M-68-c—M-68-c, Revocation—Use of materials in marketing operations has been controlled by PAW's PAO 12 for a considerable period. Issued 8-26.

EXPERIMENTAL USE OF ALUMINUM FOR CANS—M-81, Direction 4, Revocation—Restriction on use of aluminum for making cans has been removed by revocation of M-1-i and issuance of M-1-k. Issued 8-28.

ALLOCATION CONTROLS REMOVED FROM CIVILIAN PRODUCTION OF BUTADIENE—M-178, Revocation—Issued 8-24.

SIX CHEMICALS REMOVED FROM M-340'S CONTROL—M-340 as am. 8-24-44—Acetaldol, ST-115, Dehydrol-0, G.C.-78, methyl bromide, and pyronate removed from allocation. Issued 8-24.

PETROLEUM INDUSTRY HOUSING — P-98-b, Direction 1 as am. 8-26-44—Includes housing owned by petroleum operator and used by employees, as well as lease equipment housing (that located near a petroleum field). No special permission necessary for use of material to repair housing. Operator may get such repair material under P-98-b's regular procedure. An employee of a production operator may use AA-3 rating and MRO-P-3 allotment symbol for repair of any such housing, but 3 copies of delivery order must first be submitted to PAW district office for approval, and orders placed with supplier must contain, in addition to standard certification required by P-98-b, a certificate of need signed by both employer and employee. Instructions for the construction of housing by a production operator and his employees are included in this direction. Issued 8-26.

RESTRICTIONS REMOVED ON DOLLAR VALUE OF REAGENT CHEMICALS TO WHICH PREFERENCE RATINGS MAY BE APPLIED—P-135, as am. 8-24-44 — Issued 8-24.

RUBBER RESTRICTIONS—R-1 as am. 8-25-44—All medium-sized highway truck tires are now to contain 90% (instead of 70%) synthetic rubber. Special purpose tires, including earth movers, rock service, logger types, have been converted from 100% natural rubber to 35% synthetic, due to increased supply of high tenacity rayon cord. All truck tubes and many airplane tubes are converted to synthetic by this amendment. Restrictions on use of Buna S (general-purpose synthetic), reclaimed, and scrap rubber eased. Issued 8-25.

DISTRIBUTION AND USE OF RUBBER END PRODUCTS—R-1, Appendix III as am. 8-25-44—Specifications of permitted airplane and truck-bus tires amended to coincide with changes noted in R-1 as amended, **above.** Issued 8-25.

SALES OF IDLE, EXCESS, FROZEN MATERIALS—Pri. Reg. 13, as am. 8-18-44—Pri. Reg. 13 now includes sales of controlled materials, and all sales by government agencies. WPB may issue special permission to sell idle or excess controlled materials for permitted uses to persons with and without allotments. Those with allotments need not charge such purchases against their allotment account. Seller may apply for this permission in person or by letter, wire, or telephone to the WPB regional office. Issued 8-18.

HOUSING FOR PETROLEUM OPERATORS —Directive 24, Interp. 1 as am. 8-21-44—Application for housing by production operators comes under P-98-b, as outlined above. Applications for all other types of housing needed in the petroleum industry must be filed under P-55-c, including housing for refineries, other plants, and for petroleum distribution outlets. Issued 8-21.

MRO SYMBOL FOR INSTALLATION MATERIALS—CMP 5, Direction 15. as am. 8-19-44—Any business listed on Schedule I or II of CMP 5, or assigned a rating by Direction 21 to CMP 5 may use MRO symbol to get materials to install or relocate equipment where construction under L-41 is involved. If construction is not involved, up to $500 worth of installation materials may be procured to install machinery or equipment specifically authorized on a special form, such as WPB-541, WPB-1319, etc. Issued 8-19.

OIL-LAW-Gram Service

Complete texts of all orders or amendments digested in war-oil orders can be had from Platt's Oil-LAW-Gram, 1213 West 3rd street, Cleveland 13, Ohio. Minimum charge single copies $1. Copies of these texts are always in stock but large orders can be promptly filled by reprinting as plates and stencils are also kept.

Complete daily Oil-LAW-Gram service, with necessary binders, $100 per year in advance.

Due care and judgment have been taken in preparing and publishing these digests and in reproducing the original texts but the publisher does not warrant their absolute legal completeness nor accuracy. Important decisions by the reader should be made only after careful study of complete texts.

Foreign Economic Administration

WSA REPRESENTATIVE MUST APPROVE AMOUNT OF BUNKER FUEL ALLOWED FOR EACH VOYAGE OF CERTAIN VESSELS—August 25th Ruling—The amount of bunker fuel which may be exported for use on board by a vessel for which a certificate has been issued by the War Shipping Administration, or a certifying agency, such as British Ministry of War Transport, Soviet Supply Purchasing Commission, etc. shall not exceed the quantity recommended by an authorized WSA representative by endorsement on the certificate. Issued 8-25.

Office of U. S. Attorney General

RELATION OF ANTI-TRUST LAWS TO RECONVERSION PLANNING — Correspondence between Attorney General and WPB General Counsel—Consultation with industry advisory committees does not constitute violation of anti-trust laws, but private agreement by members of the committees on any plan or program, or promise to take part in such plan involving, directly or indirectly, the production or distribution of commodities would be subject to anti-trust laws. Letter of 6-27 and reply of 7-5; letter of 6-28 and reply of 7-6.

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More Stripper Pools To Get Premium

NPN News Bureau

WASHINGTON—OPA this week extended its stripper well premium payment program to 24 additional pools in six states with issuance of Order 18 to RMPR 436, effective Aug. 1. Payments on production from these pools will thus be retroactive to Aug. 1. Pools and respective increases granted are:

Indiana—Alford, Pike County, 35 cts. per bbl.; Barrett Mitchell, Gibson County, 35 cts.; Monroe City, Knox County, 35 cts.; Oakland City, Pike County, 35 cts.; Princeton East, Gibson County, 35 cts.; Dodd's Bridge (Old Shallow) Sullivan County, 35 cts.; Sullivan, Sullivan County, 35 cts.; Tri-County, Gibson and Pike Counties 35 cts.; Santa Claus, Spencer County, 35 cts.; Vernon Heights, Vanderburgh County, 25 cts.

Kansas—All pools, Bourbon County, 35 cts.; Climax, Greenwood County, 35 cts.; Fankhauser, Lyon and Agreenwood Counties, 35 cts.; Lost Springs East, Marion County, 35 cts.; New Albany, Elk County, 35 cts; Quincy, Greenwood County, 35 cts.; Wintershied, Coffey and Woodson Counties, 35 cts.

Louisiana—Georgetown, Grant Parish, 20 cts.; Tullos-Urania, La Salle and Winn Parishes, 20 cts.

Oklahoma — Boston Northeast, Osage County, 35 cts.; Cole, Payne County, 35 cts.; Penn Creek, Osage County, 25 cts.

California — Chico Martinez, Kern County, 20 cts.

Wyoming—West Salt Creek (Shale), Natrona County, 35 cts.

In another order (No. 19 to MPR 436) issued Sept. 6 and effective Aug. 1, OPA increased premium payment of 25 cts. per bbl. previously granted to Caddo (Pine Island) pool in Caddo Parish of Louisiana to 35 cts. per bbl.

Earlier, OPA had announced that 12 other stripper pools were granted premium payments. Order 17 to RMPR 436 listed the following pools for payment:

Oklahoma—Canfield, Pawnee County, 35 cts. per bbl.; Huffman, Pottawatomie County, 35 cts.; Lookout, Osage County, 35 cts.; Piggot, Osage County, 25 cts.; Wilson, Pawnee County, 25 cts.; Wood, Creek County, 25 cts.

Illinois—Maud, Wabash County, 25 cts.

Indiana—Oatesville, Pike County 35 cts.; West Princeton, Gibson County, 35 cts.; Bowman, Pike County, 35 cts.

Kansas—Atyeo, Lyon County, 35 cts.

Michigan—South Adams Pool, Arenac County, 35 cts.

OPA also issued Order 16 to RMPR 436, which increased 25c per bbl, premium payment previously granted to Hewitt Pool in Carter County of Oklahoma to 35 cts per bbl. (See OILGRAM Aug. 25).

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Don't Confuse LUBRI-GAS with fuel-treating "dopes" BECAUSE:

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2. LUBRI-GAS treated fuel is a Premium Quality fuel, and therefore is logically governed by OPA Regulations applying to premium fuel.

3. LUBRI-GAS' record is absolutely clear. It was NOT included in the recent criticisms of 150 motor fuel "dopes" according to a letter from the National Bureau of Standards.

4. LUBRI-GAS is NOT a motor fuel "dope". There is nothing else like it.

5. LUBRI-GAS actually CLEANS and LUBRICATES your motor.

6. IF LUBRI-GAS IS WRONG, THEN LUBRICATION IS WRONG.

WHAT IS LUBRI-GAS?

LUBRI-GAS is essentially a 40 SAE Lubricating Oil. It is processed with a detergent and other chemicals so that the treated oil mixes freely with the motor fuel.

WHAT LUBRI-GAS DOES—

LUBRI-GAS enters the combustion chamber in the form of a fine, oily mist, or fog. This fog will not burn at motor temperatures. Instead, it condenses back to clean oil.

LUBRI-GAS then forms a perfect film over valves, spark plugs, cylinder walls, pistons and piston rings.

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"Lubri-Gas Treated Fuel CLEANS and LUBRICATES as it POWERS the Motor"

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New Chicago Advisory Committee Head Forecasts Better Relations with OPA; Bailout Promised

NPN News Bureau

CHICAGO—B. M. Provis, president, Metropolitan Chicago Gasoline Retailers Assn., was appointed permanent chairman of the local OPA industry advisory committee at a meeting of the committee on Sept. 1, and expressed the belief that OPA and the industry now understand one another and that the prospects are good for improving conditions for dealer operations.

On Tuesday and Wednesday of last week, OPA slapped debits totaling 278,600 gal. of gasoline on 194 stations in Chicago and nearby towns, charging the operators with having accepted counterfeit coupons in that amount.

Stations Now Open at Once

At the OPA industry advisory committee meeting on Friday, attended by Marion Isbell, OPA's newly appointed metropolitan director, it was agreed that a bail out program for dealers striving to live within regulations was necessary. It should be ready to operate within a week or 10 days, Mr. Provis said.

Another proposal was a new shrinkage allowance of ½ of 1% plus 1½% for handling losses, which it was believed would take care of all legitimate shortages of that nature. This and other proposals, however, are subject to approval of the Washington office of OPA.

"When a new service station opens," Mr. Provis continued, "the operator in the past has had to sit around for a week waiting for inventory check up and coupons. At our committee meeting, we arranged with Mr. Isbell so that the supplier can take the new dealer to the OPA metropolitan office and do business immediately, setting up the necessary records and obtaining the coupons to enable the operator to open his station at once.

In the past, also, station operators have been at the mercy of pilferers and black market vandals who robbed service stations of coupons during closed hours because OPA regulations required that coupons be left on the premises at all times. If OPA Washington approves, dealers will in the future be able to take care of their coupons in the same manner as they do their money—take them home or to a bank for safe keeping when they close up for the night.

Some of the dealers charged by OPA with accepting counterfeit coupons, or with being short coupons, Mr. Provis said, declare the charges are in error and that the tank wagon drivers serving them are in league with the black market. The dealers claim they turn sufficient legal coupons over to the drivers to balance their account, but since the coupons are not stamped or marked "cancelled" the truck drivers sell them to the black market or trade them for counterfeits which the drivers turn in as coming from the dealer.

"Suggestion by Mr. Isbell," Mr. Provis said, "was that the dealers use an indelible pencil and mark a blue line vertically down through the center of each strip of coupons after pasting on the bingo sheet. The tank wagon driver, then in the presence of the dealer, is to draw a horizontal red line across the coupons in a similar manner."

Mr. Provis emphasized that this mutilation remedy of a bad situation is still in proposal form and is not to be followed until OPA Washington approves and officially notifies the dealers and oil companies.

Shortages Bound to Result

In discussing the above proposals, Mr. Provis pointed out that the oil industry has now been under rationing for over 640 days, and during that long period, even the most conscientious operators are bound to have shortages through shrinkage, handling losses and in some cases, neglect of new service station men to collect coupons from motorists after serving them.

"The tank storage capacity of many stations," Mr. Provis said, "is only 2000 or 3000 gal., and if all of these losses total only 2 gal. of gasoline a day, over a period of 640 days, their total shortage amounts to 1280 gal.—half or nearly half of their storage capacity—which forces the dealer into the black market for coupons or forces violation of ODT's regulation for 60% of capacity delivery by tank truck drivers, or puts the dealer out of business. We don't want that, and we don't believe OPA does."

The proposed bail out program and stock loss adjustments are intended to correct that situation if put into effect.

An Exceptional Opportunity for Research Scientists

One of America's largest organizations engaged in conducting research for industrial corporations and governmental agencies is expanding its present staff of 300 people.

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Men and women who can be released from present duties and meet the above qualifications are assured salary and opportunity commensurate with ability. And, future research commitments promise postwar permanence. If you are interested, please write immediately.

[Applications are also invited from scientists who are on leave of absence from educational institutions for the duration.]

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Industry Advisory Committees Named for North Carolina

Special to NPN

RALEIGH, N. C.—Appointments to Industry Advisory Committees for each OPA district in North Carolina have been announced by W. A. Parker, Secy., North Carolina Oil Jobber's Assn.

The purpose of these committees is to afford a closer relationship between the industry and OPA in the functioning of the gasoline program. Primary objective of the move, Mr. Parker says, is to assist in the education of dealers, station attendants, and the public generally in ways and means of stamping out the

black market in gasoline coupons.

In the Eastern North Carolina region, covering 54 counties, the industry is composed of O. F. Dumas, Goldsboro, S. D. Bryan, Raleigh, representing the oil jobbers; Herbert R. Dowd, Fayetteville, Ed. M. Nadal, Wilson, representing the major suppliers; C. R. Philpot, Raleigh, representing the dealers, and H. C. Sprinkle, Durham, representing trackside operators.

Chairman of the eastern committee is oil jobber S. D. Bryan, with C. R. Philpot, a dealer as co-chairman.

In the western district a committee was appointed by the district director of OPA in Charlotte. This committee consists of J. Laurens Wright, Standard, chairman; W. B. Roberts, Gulf; W. T. Davis, Shell; C. R. Dillard, Sinclair; T. A. Aldridge, American; W. C. Fowler, Pure; J. H. Morehouse, Atlantic; F. J. Whitehurst, Cities Service; C. N. Hanna, Texaco. C. M. Barringer, president of N.C.O.J.A., is the representative for the oil jobbers, and Roby E. Taylor, for trackside operators.

Dist. 1 Putting on Pressure For Manpower Surveys

NPN News Bureau

NEW YORK—Another urgent appeal to oil companies to complete surveys which will enable the War Manpower Commission to designate "locally-needed" areas was sent on Sept. 1 to all original and secondary suppliers in PAW Dist. 1 by W. C. Burns, chairman of the manpower subcommittee for marketing of Dist. 1.

Mr. Burns asserted that the industry "has been delinquent in getting its marketing division declared "locally needed'." He pointed out that under a new directive issued by War Mobilizer Byrnes on Aug. 4, "it becomes imperative that the petroleum industry protect its manpower in the distribution and marketing division if it does not want to face the possibility of its manpower being restricted."

Affects Only Applicants

"Even though the majority in any area co-operates and files surveys and the area is declared 'locally needed,'" Mr. Burns continued, "only those companies participating in the surveys can be so declared and protected in every manpower situation. Compliance with all applicable War Manpower Commission regulations is required."

Mr. Burns explained that the distribution and marketing committee had requested state committees in all Group 1 and 2 areas to inaugurate surveys.

"We are facing a critical situation through the next six months, especially in those territories where large volumes of heating oil are distributed," he added. "It is the feeling of this committee that each and every marketer should give consideration to this problem."

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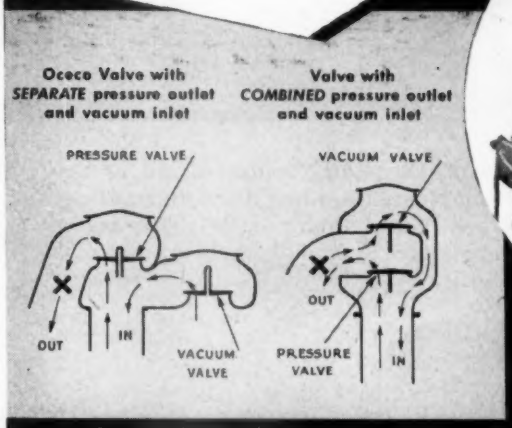

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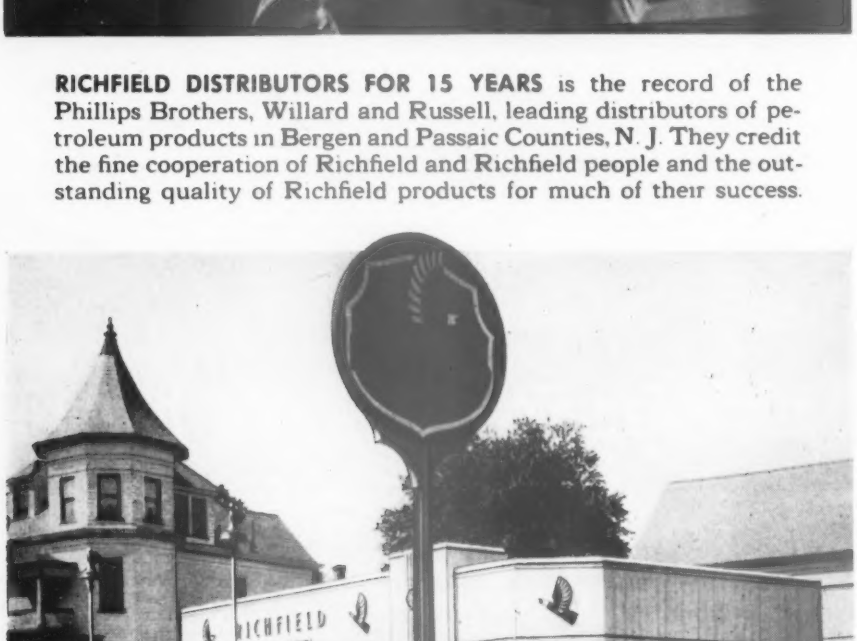

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SERVING THE EASTERN SEABOARD FROM MAINE THROUGH NORTH CAROLINA

'PETROLEUM FOR PEACE'

(*Continued from p.* 3)

of war production necessary to beat Japan."

Thus, he went on, there will be need for only one preference rating, in addition to the present emergency AAA rating, "and this rating will be reserved exclusively for military programs during the war against Japan. All other production will be unrated. Manufacturers will be permitted to accept unrated orders but they will be obliged to fill rated military orders ahead of all other business."

As for the "very few allocation orders" that will have to be continued, they will apply only to materials "that remain tight, such as lumber, textiles, and certain chemicals. For example, it will be necessary to continue strict controls of the use of lumber, particularly for major construction projects."

Describing the reconversion program as "simple in outline", the WPB chieftain said that while no programming of civilian production will be necessary after Germany's collapse, WPB nevertheless proposes to keep active its industry divisions and its industry division requirements committee for the purpose of seeing to it that certain essential industries, such as oil, don't wind up on the short side in the general rush of all industry for materials.

Specifically, on this score, he remarked as follows:

"(Their) job will be to make certain that no one is permitted to procure an unreasonable amount of any material or product, that needed materials and components are made available to top essential civilian activities such as transportation, utilities, and fuel, and that small business is given an equal opportunity to secure materials and supplies."

At a press conference late in the week, by way of a follow-up to his earlier announcement, Mr. Krug made clear the following points with respect to "X-day" reconversion:

1. As far as WPB is concerned, military needs come first and "we will keep our eye on that ball until the end of the war."

2. How rapidly reconversion to peacetime production takes place depends not only on WPB but many other agencies: Contract terminations will be determined by the procurement agencies, such as Army and Navy; problems involving surplus materials will be the responsibility of the surplus property administrator, and disposition of government plants and tools will be in the purview of Defense Plants Corp.

3. Government can help during the reconversion period, but the main job will be up to industry. WPB's job is to "remove every obstacle that might prevent industry from going ahead boldly".

4. The reason for retaining WPB's industry division and committee setup is to aid and work with such industries as petroleum, transportation, farm machinery, etc., to help them obtain their needs as far as possible through the

normal trade channels to which they are accustomed.

Asked specifically about the prospects for fuel and gasoline after the end of the European phase of the war, Krug said that petroleum supplies for civilians "probably will be short for some time, but the Petroleum Administration knows more about that than we do." As regards rationing in general, Krug said that it was WPB's view that such controls should be continued "until the supply makes it unnecessary to ration."

1,000,000 Blitz Cans Offered For Immediate Sale

NPN News Bureau

WASHINGTON — Surplus property office of the treasury department procurement division is offering approximately 1,000,000 five-gal. steel army "blitz" cans for immediate sale.

Cans have been declared surplus by Army. They are made of heavy 20 gauge steel, 13½ by 6⅝ x 18¼, are of solid welded construction; have an easy-pouring spout, and are described as "ideal for carrying or storing gasoline, kerosine, fuel oil, or any non-corrosive liquid."

Prices quoted are divided into three classes, to assure equitable distribution nation-wide and to give chance to smaller retailer to make purchases. The prices range from 75c to 90c per can.

Samples may be inspected at any one of the following regional treasury procurement offices: Boston, New York, Washington, D. C., Cincinnati, Chicago, Atlanta, Fort Worth, Kansas City, Denver, San Francisco, Seattle.

Candidates Eligible for 'Gas'

NPN News Bureau

WASHINGTON — OPA this week issued Amendment 147 to RO 5C, effective Sept. 11, making campaign managers of candidates for state or federal office eligible for special gasoline rations equivalent to "B" rations.

Coming Meetings

SEPTEMBER

American Chemical Society, New York City, Sept. 11-15.

Empire State Petroleum Assn., Inc., fall meeting, Hotel Commodore, New York City, Sept. 20-21.

Michigan Petroleum Assn., Park Place Hotel, Traverse City, Sept. 26-27.

OCTOBER

American Assn. of Oil Well Drilling Contractors, annual meeting, Ft. Worth, Oct. 3-4.

Indiana Independent Petroleum Assn., fall meeting, Indianapolis, Oct. 11-12.

I.P.A.A. Director's Meeting, Dallas, Oct. 9-11.

National Lubricating Grease Institute, Edgewater Beach Hotel, Chicago, Oct. 23-25.

Ohio Petroleum Marketers Assn., Deshler-Wallick Hotel, Columbus, O., Oct. 25-26.

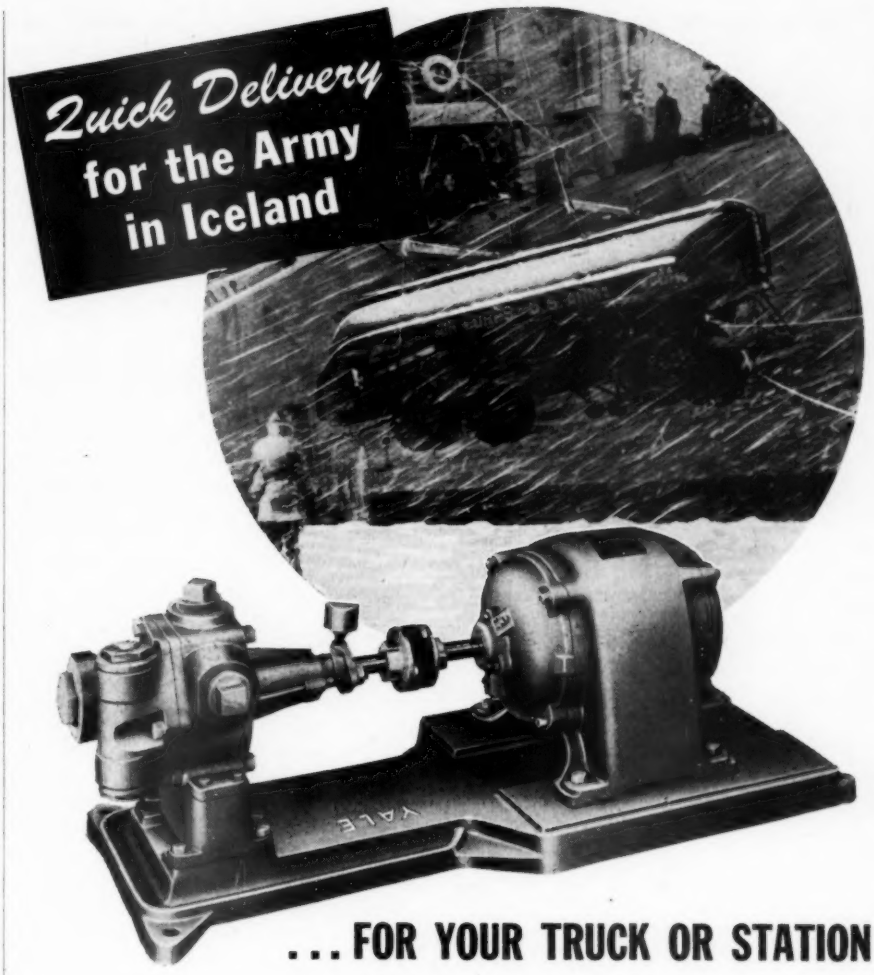
NOVEMBER

Society of Automotive Engineers Air Transport and Engineering Meeting, Kansas City, Nov. 16-17.

South Dakota Independent Oil Men's Assn., Mitchell, S. D., Nov. 27-28.

DECEMBER

Nebraska Petroleum Marketers Inc., Fontenelle Hotel, Omaha, Nebr., Dec. 5-7.



... FOR YOUR TRUCK OR STATION

TRI-ROTOR PUMPS—like the ones being furnished for pumping aviation fuels on all fighting fronts—are now available for domestic truck and bulk stations upon receipt of order bearing AA-5 or better priority. The higher the priority, the quicker the delivery.

TRI-ROTORS, manufactured by Yale & Towne, are the only *low pressure* pumps combining the *power economy* of rotary pumps with the *positive handling* of piston pumps. There is no *overheating, chewing, foaming* or *aerating* of the product.

TRI-ROTOR PUMPS have only three moving parts, two being pumping members. This means the highest kind of efficiency with a minimum of maintenance. They are furnished with solid, by-pass or variable volume type heads, and in the following sizes: (1¼"—20 G.P.M.); (1½"—40 G.P.M.); (2"—80 G.P.M.); (2½"—90 G.P.M.); (3"—100 G.P.M.); (4"—200 G.P.M.)

WHEN ORDERING, SPECIFY: "iron or bronze fitted", "type of head", "direction of rotation, clockwise or counterclockwise". Detailed data on request. Please direct your inquiry to Pump Division, The Yale & Towne Manufacturing Co., 215 Henry St., Stamford, Conn., U. S. A.

TRADE **YALE** MARK

PUMP DIVISION

Makers of the
Famous Yale Line of Locks, Hardware, Hoists & Industrial Trucks

THE YALE & TOWNE MANUFACTURING COMPANY, STAMFORD, CONNECTICUT

WITH PLATT IN ENGLAND

(*Continued from p. 9*)

overlooked and that drew more criticism from this judge, who said:

"Why not say with candour that Ministers can make regulations when, how, and on what subjects they please or, to put it more brutally, why not claim a dictatorship sheltering under the all-embracing umbrella of the "Safety of the Realm' . . .

"I intend to be no party to what I have described as attempts by some departments to establish government by dictatorship. The time has come to take a strong stand on behalf of all those who are anxious to see our liberties preserved . . .

"The rise of Bureaucracy is at present a swelling tide, but we must see to it that it does not overstep the strict bounds of present necessity, and that its life is not prolonged, and that the anachronism of ex post facto legislation does not become normal procedure or become a cloak for the overthrow of those liberties for the existence of which we all, it is hoped, are fighting."

But over in our own country no "directives" have to be submitted to congress and we have heard much of the "War Powers of the President" which can be likened to what this judge describes as "Safety of the Realm" powers.—W. C. P.

Editorial Lauds Industry's Contribution to War

LONDON—Praise for industry for its contribution to this war and praise for the fact that industry has done such a good job that the United Allied Armies' Services of Supply could take the invasion of Southern France "in their stride", is the subject of the editorial in the *LONDON DAILY MAIL* of Aug. 16th.

Here is what it says as to how well industry has done ITS job, under the heading of "Fourth Front":

"The invasion of Southern France is an occasion for wonder as well as for rejoicing. It is awe-inspiring to think of the infinite resources which have made such an achievement possible.

"Such, too, will be the reflection of our enemies, except that awe will be driven out by fear. For this is the fourth major seaborne expedition launched by the Western Allies.

"What industrial phenomenon is it that has made such an achievement possible? The factories of Britain and America are supplying the unceasing demands of every theatre of the war. Yet in spite of such burdens we can still take in our stride an expedition which would almost have crippled an industrial nation a generation ago.

"Our ships ply the oceans incessantly, yet 800 can be spared to land troops along 100 miles of the Riviera coast. Our fleets control the seas, yet they can protect these great convoys in force. Our planes pound the enemy over vast areas by day and night, yet they can still mount a great preliminary offensive in Southern France and carry the largest airborne army ever to be put into action from our side.

"How foolish were the Germans to challenge the productive power, the sinewy resolve, the ingenuity, and the organizing power of the United Nations. They can see their folly now, when from east, south, west and south-west great armies are advancing inexorably towards the doomed Third Reich.

"The two-front war was always a German nightmare. Now they have to fight a four-front war—for Southern France is a sector worthy to rank with the other big fronts."—*W. C. P.*

Roman Roads Big Help to English War Machines

Roads built in England by the old Romans a couple of thousand years ago (look it up in your own encyclopedia if you want it exactly) have helped the prosecution of this war mightily. There are a good many hundreds of miles of these roads. They have been built up and regraded and resurfaced many times, of course, but the old routes have been followed for the most part and old foundations and draining used. The result is that despite the heavy traffic of a few hundred thousand of war vehicles the past four years, the writer has not seen any damage to the roads and, he is told, no repairs, at least of consequence, have been made during the war.

The Romans ran their roads as straight as an arrow. However, when four-wheeled vehicles came into use, residents departed from the straight line to run roads around hills in order to get easier grades. One explanation of how these roads were run straight, as given by one Englishman, is that, as the Romans had no single point far distant to go, only just north or east or west, they walked a man out a fair distance in the desired direction, put a third man beyond and then kept to the line the three men made. Still, these roads look a bit too straight for any such casual surveying method. They must have used something else which, perhaps, history already has recorded for the engineers.

One big reason why English roads are good, in addition to their age, is the absence of hard freezes that get down under the surfacing. At least in southern England, there is little, if any, of that in winter and in the summer there is none of the high temperatures such as the U.S. has and which expands even well-laid pavement until it breaks up.—W. C. P.

Order on Lube Prices Revised by OPA

NPN News Bureau

WASHINGTON—OPA this week revised its maximum price order dealing with lube oils, greases, and other related products, because certain sections have proved to be ambiguous. This has resulted in an excessive amount of correspondence between OPA and sellers in order to elicit information necessary to substantiate new maximum prices set by sellers.

In amending Section 16 of MPR 510, certain principles which OPA has been following have been translated into a method of pricing which it is believed will be applicable in establishing a large majority of the maximum prices coming under the section.

The new pricing method is described as the "comparable products margin" and provides for the establishment of a maximum price on the basis of the average of the percentage mark-ups on two of the seller's comparable products on which he has set maximum prices. That is, seller chooses the two most comparable products, calculates the percentage mark-up included in the maximum price of each product, takes an average of these two percentage mark-ups and uses this figure in determining his mark-up in the new maximum price.

A form is provided for reporting to OPA in Washington, all maximum prices established by this new "comparable products margin" method. When this method cannot be used for some reason, the seller is permitted to set his maximum price under the second part of the section which allows him to submit any information which he feels will substantiate his new maximum price, either with reference to maximum prices of other products in his line, or on basis of competitive products or by whatever method he chooses. He is required, however, to state the maximum price, cost and enduse of the most comparable product in his line even though such a product does not qualify as a "comparable product" under the first method.

Action was taken in Amendment 3 to MPR 510, effective Sept. 5.

Set Texas Sweet Gas Quotas

Special to NPN

AUSTIN, Tex.—The Texas Railroad Commission has authorized the withdrawal of 36,582,967 cubic feet daily of sweet natural gas from the Rodessa Field in September, allocated between the Young, Gloyd and Hill sands.

Market Reports

ATLANTIC COAST — Three East Coast refiners reduced their ceilings in compliance with OPA Amdt. No. 16 to MPR 88 on 70-44 octane gasoline making new price ranges as follows: 8.125-8.4c at Savannah; 8.145-8.275c at Tampa; 9.075-9275c at N. Y. tank cars; 8.975-9.175c at New York barges and 9.175-9.3c at Albany. Other prices fell within existing ranges. Other refiners contacted not ready to release new quotations.

° ° °

GULF COAST—One refiner in this area now quoting 4.125c on 41-43 kerosine tank cars and barges; and withdrew his quotations on 48-52 and 58 and above D. I. fuel oil as he is no longer making these products.

One refiner reports Bunker "C" fuel oil supply piling up due to the warm weather and storages being filled up as per PAW's request to industry. Kerosine supply fair and supply of No. 2 fuel oil plentiful.

° ° °

MIDCONTINENT—Flat price of 4.1c on No. 1 p.w. in Kansas was lowered when refiner re-entered market with posting of 4c, making range 4-4.1c. Fall demand for burning oils is beginning, refiners say, but kerosine continues very slow in most areas. Range oil call increasing, according to Oklahoma refiner who said he was receiving more inquiries than he could take care of.

Heavy fuel oil reported backing up in Arkansas and Kansas with war plants asking PAW for relief. Storage capacities of railroads in the Southwest said to be full also.

Only slackening in heavy gasoline demand noted in Kansas where refiners say recent rains keeping farmers from fields have caused slight letup. Transportation unimproved.

Six cars Grade 26-70 natural gasoline reported sold at 4.75c f.o.b. Group 3, and one car reported sold at 4.375c f.o.b. Breckenridge.

° ° °

PENNSYLVANIA—One lower field refiner reduced his prices in accordance with Amdt. 17 to MPR 88 effective Sept. 1. His quotations now are 7.725c for "Q" gasoline, 7.125c for 45 and 46 w.w. kerosine, 7.375c for 47 w.w. kerosine and 6.875c for Nos. 1, 2, 3 and 36-40 fuel oils. New ranges for other districts are: 7.75-8c for "Q" gasoline, 7.125-7.375 for 46 w.w. kerosine and 6.875-7c for No. 1 fuel oil. Balance of ranges are unaffected.

° ° °

MIDWEST—Midwestern refiners, still confused as to application of Amd. 15 to MPR 88, particularly concerning Group 3 gasoline and kerosine prices on shipments into Indiana and Chicago metropolitan area, where they say some adjustment may be necessary. One refiner has posted prices a half cent below regular midwestern ceiling on all grade gasoline for shipment f.o.b. Tulsa into this area. Prices, however, apply only to contract jobbers or distributors and to all contract consumers with contracts based on seller's posted tank car price, f.o.b. Tulsa, and have made no change in midwestern price ranges. Some action by refiners on the order is expected this week.

Overflowing residual oil storages have meant no offers of material at below ceiling prices, refiners and marketers reported last week. Suppliers, knowing their regular customers are dependent on them for other products, sell them at ceiling and offer no open spot material because small amount they could sell at reduced price would not justify break in market which would result, they say. Kerosine supplies are reported loosening up with very little moving from midwest into Dist. 1. Refiners and marketers storing all available kerosine for shipment on No. 1 distillate orders during heating season, since the No. 1 product is rapidly becoming non-existent because of greater profit available when kerosine is supplied on such orders.

CRUDE PRICES

Since changes in crude oil prices are so few, the two pages of crude oil price tables hereafter will be printed only when there are sufficient changes in prices to warrant.

In the meantime a record is being kept in the Cleveland office of NPN and OILGRAM from which the publishers will be glad to make proofs, or letters or affidavits as to what the prices are, and without charge to regular subscribers. Changes in crude oil prices will be specially noted in this market section when made.

Crude Price Changes

Gulf Refining announced 5c *raise in prices for New Hope, Franklin County, Texas crude, effective Sept.* 1. *New schedule begins with* 25-25.9 *at* $0.95 *with* 2c *differential and ends with* 40 & *above at* $1.25.

Magnolia Petroleum Co. announced schedule for Fullerton and Union fields (Clear Fork formation, Permian system) in Andrews County, Texas, beginning with Below 20 *at* $0.83 *with* 2c *differential and ending with* 40 & *above at* $1.25.

Arkansas Fuel Oil announced schedule for Blossom sand, Haynesville area in Louisiana, beginning with Below 25 *at* $0.88 *with* 2c *differential and ending with* 40 & *above at* $1.20.

For latest table of crude prices published, see NPN, Aug. 23, *pages* 49, 50 *and* 46.

Summary of Daily Gasoline Prices (August 28 to September 5)

U. S. Motor (ASTM octane)	Tuesday Sept. 5	Friday Sept. 1	Thursday Aug. 31	Wednesday Aug. 30	Tuesday Aug. 29
76 octane Ethyl:					
Oklahoma	6.75	6.75	6.75	6.75	6.75
Mid-Western (Group 3 basis)	6.75 – 7.25	6.75 – 7.25	6.75 – 7.25	6.75 – 7.25	6.75 – 7.25
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7	7	7	7	7
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7 (2)	7 (2)	7 (2)	7 (2)	7 (2)
70-74 octane:					
Oklahoma	5.875	5.875	5.875	5.875	5.875
Mid-Western (Group 3 basis)	5.875	5.875	5.875	5.875	5.875
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.875	5.875	5.875	5.875	5.875
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.875	5.875	5.875	5.875	5.875
63-66 octane:					
Oklahoma	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)
Mid-Western (Group 3 basis)	5.625 (2)	5.625 (2)	5.625 (2)	5.625 (2)	5.625
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.75 (1)	5.75 (1)	5.75 (1)	5.75 (1)	5.75 (1)
60 octane & below:					
Oklahoma	5.25	5.25	5.25	5.25	5.25
Mid-Western (Group 3 basis)	5.2 – 5.25	5.2 – 5.25	5.2 – 5.25	5.2 – 5.25	5.2 – 5.25
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.2 – 5.25	5.2 – 5.25	5.2 – 5.25	5.2 – 5.25	5.2 – 5.25
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.25	5.25	5.25	5.25	5.25
Motor Gasoline, 70-74 oct.					
New York harbor	9.075– 9.2	9.075– 9.2	9.075– 9.2	9.075– 9.2	9.075– 9.2
New York harbor, barges	8.975	8.975	8.975	8.975	8.975
Philadelphia district	9.075– 9.2	9.075– 9.2	9.075– 9.2	9.075– 9.2	9.075– 9.2
Baltimore district	8.825– 8.95	8.825– 8.95	8.825– 8.95	8.825– 8.95	8.825– 8.95
Motor Gasoline:					
Western Penna. Bradford-Warren:					
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.625– 8.825	7.625– 8.825	7.625– 8.825	7.625– 8.825	7.625– 8.825
Western Penna. Other Districts:					
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.75 – 8	7.75 – 8	7.75 – 8.45	7.75 – 8.45	7.75 – 8.45

Note: To conform with Article IV of MPR 88 as amended August 15 we are substituting 70-74 oct. ASTM for the old 72-74 oct. ASTM. We continue to include in this group, Housebrand quotations. 70-74 oct. prices effective Aug. 15.

Refinery Operations

(American Petroleum Institute figures in thousands of barrels of 42 gal. each. Figures include reported totals plus estimate of unreported amounts and are therefore on a Bureau of Mines basis.)

Districts	Daily Potential Refining Capacity Week Ended Aug. 26	Daily Potential Refining Capacity Week Ended Aug. 19	Per Cent of Refining Capacity Reporting Week Ended Aug. 26	Per Cent of Refining Capacity Reporting Week Ended Aug. 19	Daily Average Crude Runs to Stills Week Ended Aug. 26	Daily Average Crude Runs to Stills Week Ended Aug. 19	Per Cent of Reporting Capacity Operated Week Ended Aug. 26	Per Cent of Reporting Capacity Operated Week Ended Aug. 19
Combined**	2,518	2,518	90.3	90.3	2,498	2,468	99.2	98.0
Appalachian (Dist. No. 1)	130	130	83.9	83.9	116	105	89.2	80.8
Appalachian (Dist. No. 2)	47	47	87.2	87.2	59	56	125.5	119.1
Ind., Ill., Ky.	824	824	85.2	85.2	749	799	90.9	97.0
Okla., Kans., Mo.	418	418	80.2	80.2	383	385	91.6	92.1
Rocky Mt. (Dist. No. 3)	13	13	17.0	17.0	11	11	84.6	84.6
Rocky Mt. (Dist. No. 4)	141	141	58.3	58.3	99	96	70.2	68.1
California	817	817	89.9	89.9	783	774	95.8	94.7
Total U.S.—B. of M. Basis	4,908	4,908	87.2	87.2	4,698	4,694	95.7	95.6
U.S.—B of M Basis Aug. 28, 1943					4,277			

Districts	Gasoline Production at Refineries inc. Natural Blended Week Ended Aug. 26	Gasoline Production at Refineries inc. Natural Blended Week Ended Aug. 19	Stocks of Finished and Unfinished Gasoline Week Ended Aug. 26	Stocks of Finished and Unfinished Gasoline Week Ended Aug. 19	Total Stocks Gas Oil & Distillates Week Ended Aug. 26	Total Stocks Gas Oil & Distillates Week Ended Aug. 19	Total Stocks Residual Fuel Oil Week Ended Aug. 26	Total Stocks Residual Fuel Oil Week Ended Aug. 19
Combined**	7,045	7,002	36,776	38,226	22,182	21,387	19,128	18,106
Appalachian (Dist. No. 1)	329	311	2,182	2,137	529	595	290	328
Appalachian (Dist. No. 2)	177	195	1,435	1,434	225	183	178	170
Ind., Ill., Ky.	2,718	2,684	17,783	17,718	5,987	5,943	4,290	4,349
Okla., Kans., Mo.	1,428	1,327	6,609	6,652	1,922	1,834	1,432	1,422
Rocky Mt. (Dist. No. 3)	34	35	58	54	9	3	30	35
Rocky Mt. (Dist. No. 4)	371	330	1,971	2,014	359	354	659	637
California	2,010	1,873	13,926	13,615	10,330	10,009	33,332	33,690
Total U.S.—B. of M. Basis	14,112	13,757	*80,740	81,850	41,543	40,308	59,339	58,737
U.S.—B. of M. Basis Aug. 28, 1943	12,398		71,636		36,410		66,724	

*Finished 68,108,000 bbls.; Unfinished 12,632,000 bbls.
**Includes East Coast, Inland Texas, Texas Gulf, Louisiana Gulf and North Louisiana-Arkansas districts.

U. S. Crude Oil Production

(American Petroleum Institute figures)

	WEEK ENDED Barrels Aug. 26 (Daily Average)	Barrels Aug. 19 (Daily Average)
Oklahoma	342,000	340,000
Kansas	278,900	285,300
Nebraska	500	550
Texas	2,108,600	2,108,600
Louisiana	362,450	362,700
Arkansas	80,900	80,650
Mississippi	45,900	45,750
Alabama	200	200
Florida	50	50
Illinois	205,500	210,500
Indiana	13,000	12,850
Eastern (Ill., Ind. & Ky. excluded)	69,450	69,000
Kentucky	24,300	24,550
Michigan	50,600	49,400
Wyoming	85,100	87,450
Montana	19,600	21,800
Colorado	8,650	8,450
New Mexico	106,050	106,000
California	865,700	861,300
Total, U. S.	4,667,450	4,675,100

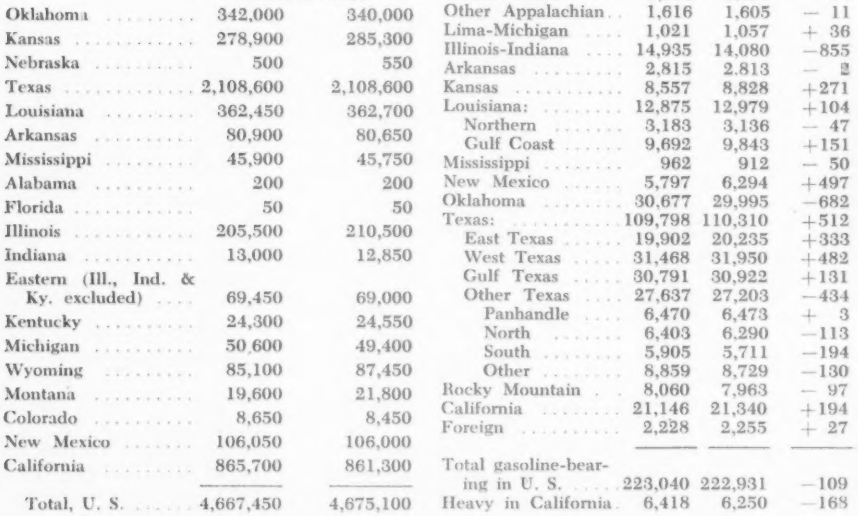
Crude Oil Stocks

(Bureau of Mines Figures in thousands of bbls.)

Grade or Origin	Aug. 19	Aug. 26	Change from Aug. 19
Penna. Grade	2,553	2,500	— 53
Other Appalachian	1,616	1,605	— 11
Lima-Michigan	1,021	1,057	+ 36
Illinois-Indiana	14,935	14,080	—855
Arkansas	2,815	2,813	— 2
Kansas	8,557	8,828	+271
Louisiana:	12,875	12,979	+104
Northern	3,183	3,136	— 47
Gulf Coast	9,692	9,843	+151
Mississippi	962	912	— 50
New Mexico	5,797	6,294	+497
Oklahoma	30,677	29,995	—682
Texas:	109,798	110,310	+512
East Texas	19,902	20,235	+333
West Texas	31,468	31,950	+482
Gulf Texas	30,791	30,922	+131
Other Texas	27,637	27,203	—434
Panhandle	6,470	6,473	+ 3
North	6,403	6,290	—113
South	5,905	5,711	—194
Other	8,859	8,729	—130
Rocky Mountain	8,060	7,963	— 97
California	21,146	21,340	+194
Foreign	2,228	2,255	+ 27
Total gasoline-bearing in U. S.	223,040	222,931	—109
Heavy in California	6,418	6,250	—168

Crude Production & Runs to Stills

(Millions of Barrels)


Crude Output
Runs to Stills
1944
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1942
1943
1944
JULY
AUG
SEPT

N.P.N. Gasoline Index

	Dealer T.W. Cents	Tank Car Per Gal.
Aug. 28	9.17	5.52
Month ago	10.51	6.17
Year ago	10.37	6.92

Dealer index is an average of "undivided" dealer prices, ex-tax, in 50 cities.

Tank car index is weighted average of following wholesale markets for regular-grade gasoline, FOB refineries or terminals: Okla., Mid-Western, W. Penna., Calif., N. Y. Harbor, Philadelphia, Jacksonville, Boston and Gulf Coast.

Pennsylvania Crude Runs

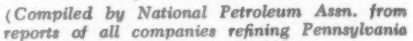
(Compiled by National Petroleum Assn. from reports of all companies refining Pennsylvania crude. Figures in bbls.)

DAILY AVERAGE

Week Ended Aug. 26, 1944	Week Ended Aug. 19, 1944	Week Ended Aug. 8, 1943
71,429	71,410	78,000

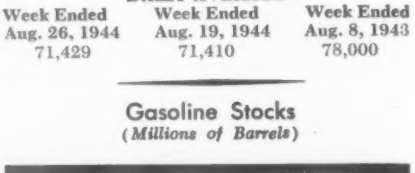
Gasoline Stocks

(Millions of Barrels)



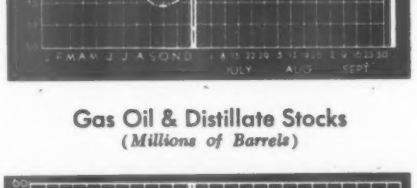
Gas Oil & Distillate Stocks

(Millions of Barrels)



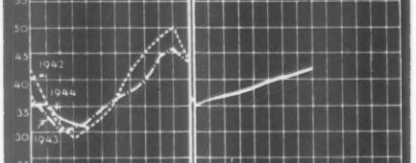
Residual Fuel Oil Stocks

(Millions of Barrels)



Crude Oil Stocks

(Millions of Barrels)



OIL PRICE SECTION ★ At Refineries and Terminals and by Tank Wagon

Prices herewith are reproduced from Platt's *OILGRAM* Daily Oil Price Service, associated with National Petroleum News, whose representatives in all *NPN-OILGRAM* offices devote their time exclusively to reporting oil industry prices everywhere.

Prices shown are actual sales prices, or quotations meaning sellers' general offers or posted prices; for current sales and shipment; for the business day or period stated; except Tank Wagon prices, prices are for bulk lots such as tank car and motor transport; barge or tanker cargo lot prices are identified; FOB refineries or terminals; in cents per gal. except where shown in bbls. of 42 gals.; ex all fees and taxes; for crude oil and its products lawfully produced and transported; reported as received by *OILGRAM* and National Petroleum News but not guaranteed; for subscribers' private use only and not for resale or distribution or publication. For further details of price conditions apply to any *NPN-OILGRAM* office or see back of any *OILGRAM* Price Service invoice.

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Refinery Prices

Gasoline —U. S. Motor (A S T M) except where otherwise specified.

Prices in Effect	Sept. 5	Aug. 28
OKLAHOMA		
76 oct. Ethyl	6.75	6.75
70-74 oct.	5.875	5.875
63-66 oct.	5.625 (1)	5.625 (1)
60 oct. & below	5.25	5 – 5.25
MID-WESTERN (Group 3 basis)		
76 oct. Ethyl	6.75 – 7.25	6.75 – 7.25
70-74 oct.	5.875	5.875
63-66 oct.	5.625 (2)	5.625
60 oct. & below	5.2 – 5.25	5.2 – 5.25
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
76 oct. Ethyl	7	7
70-74 oct.	5.875	5.875
63-66 oct.	5.625 (1)	5.625 (1)
60 oct. & below	5.2 – 5.25	5.2 – 5.25
W. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
76 oct. Ethyl	7 (2)	7 (2)
70-74 oct.	5.875	5.875
63-66 oct.	5.75 (1)	5.75 (1)
60 oct. & below	5.25	5.25
CENT. W. TEX. (Prices to truck transports)		
76 oct.	7 (2)	7 (2)
70-74 oct.	5.875– 6 (2)	5.875– 6 (2)
67-69 oct.	....	....
62 oct. & below	5.25 (2)	5.25 (2)
KANSAS (For Kansas destinations only)		
76 oct. Ethyl	7.2 – 7.3	7.2 – 7.3
70-74 oct.	6.2	6.2
63-66 oct.	5.9 (2)	5.9 (2)
60 oct. & below	5.5	5.5
ARK. (For shipment to Ark. & La.)		
76 oct. Ethyl	7 (1)	7 (1)
70-74 oct.	5.875 (1)	5.875 (1)
62 oct. "	....	....
60 oct. & below, unleaded	5.25 (1)	5.25 (1)
WESTERN PENNA. (Motor gasoline)		
Bradford-Warren:		
"Q" Gasoline Min. 70 Oct. (ASTM)	7.625-8.825(a)	7.625-8.825(a)
Other districts:		
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.75 – 8	7.75 – 8.325

(a) Highs and lows for Schedule D area, in RPS 88 and outside Schedule D area, respectively.

Prices in Effect	Sept. 5	Aug. 28
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
U.S. Motor: (Oct. ASTM):		
70-74 oct.	7.875– 8.375	7.875– 8.375
67-69 oct.	....	....
Str. run gasoline, excluding Detroit shpt.	6	6
OHIO (S. O. Ohio quotations for statewide delivery and subject to exceptions for local price disturbances).		
70-74 oct.	8.25	8.25
CALIFORNIA U.S. Motor:		
76 oct. (Ethyl)	7.5 – 8.75	7.5 – 8.75
70-74 oct.	6.5 – 7.75	6.5 – 7.75
65 oct. & below (3rd grade)	6.5 – 6.75	6.5 – 6.75

Note: To conform with Article IV of MPR 88 as amended August 15 we are substituting 70-74 oct. ASTM for the old 72-74 oct. ASTM. We continue to include in this group Housebrand quotations.

Kerosine, & Gas Fuel Oils

Prices in Effect	Sept. 5	Aug. 28
OKLAHOMA		
41-43 grav. w.w.	4.375	4.375
42-44 grav. w.w.	4.5	4.5
Range oil	4	4
No. 1 p.w.	3.875	3.875
No. 1 straw	....	....
No. 2 straw	3.625	3.625
No. 3 fuel	3.5 (2)	3.5 (2)
No. 6 fuel	$0.97 (1)	$0.97 (1)
U. G. I. Gas Oil	....	....
14-16 fuel	$0.97 (2)	$0.97 (2)
MID-WESTERN (Group 3 basis)		
41-43 grav. w.w.	4.375	4.375
42-44 grav. w.w.	4.5	4.5
Range Oil	4 –4.1 (2)	4 –4.1 (2)
No. 1 p.w.	3.875	3.875
No. 2 straw	3.625	3.625
No. 3	....	....
No. 5	....	....
No. 6	$0.97 (1)	$0.97 (1)
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
41-43 grav. w.w.	4.375	4.375
42-44 grav. w.w.	4.5 (1)	4.5 (1)
No. 1 p.w.	3.875 (1)	3.875 (1)
No. 6 fuel	$0.97 (2)	$0.97 (2)
AMARILLO, TEX. (For shpt. to W. Okla. & Tex. differential territory.)		
42-44 grav. w.w.	4.5 (1)	4.5 (1)
KANSAS (For Kansas destinations only).		
41-43 grav. w.w.	No Price	No Price
42-44 grav. w.w.	4.7 – 4.75	4.7 – 4.75
No. 1 p.w.	4 – 4.1	4.1 (2)
No 6 fuel	$1.02	$1.02
ARK. (For shipment to Ark. and La.)		
41-43 grav. w.w.	....	....
42-44 w.w. kero	4.5 (1)	4.5 (1)
No. 1	4 (1)	4 (1)
No. 2	3.625 (1)	3.625 (1)
No. 3 fuel	3.5 (1)	3.5 (1)
Tractor fuel, for shpt. to Ark. points only	5.125 (1)	5.125 (1)
Diesel fuel 52 & below	4 (1)	4 (1)
Diesel fuel 58 & above	4.25 (1)	4.25 (1)
WESTERN PENNA.		
Bradford-Warren:		
45 grav. w.w.	6.55 – 8.05	6.55 – 8.05
46 grav. w.w.	6.675 (1)	6.675 (1)
No. 1 fuel	6.55-8.05 (b)	6.55-8.05 (b)
No. 2 "	6.125-7.625(b)	6.125-7.625(b)
No. 3 "	6.25-7.75(1&b)	6.25-7.75(1&b)
36-40 gravity	6.625-6.75(2)	6.625-6.75(2)

(b) Highs and lows for Schedule D area, in RPS 88 and outside Schedule D area, respectively.

Other districts:		
45 grav. w.w.	7.25 – 7.925	7.25 – 7.925
46 grav. w.w.	7.125– 7.375	7.25 – 7.625
47 grav. w.w.	7.375– 7.875	7.375– 7.875
No. 1 fuel	6.875– 7	6.875– 7.375
No. 2 "	6.75 – 7.375	6.75 – 7.375
No. 3 "	6.75 – 7.375	6.75 – 7.375
36-40 grav. Pittsburgh dist. prices excluded	6.625– 7.375	6.625– 7.375
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
47-49 gravity w.w.	5.8 – 6	5.8 – 6
P.W. Distillate	5.5	5.5
No. 3 gas oil, Straw	5	5
U.G.I. gas oil	4.5 (2)	4.5 (2)
Fuel Oils (*Vis. at* 100).		
300-500 Vis.	....	....
100-300 Vis.	4.5	4.5
OHIO (S. O. quotations for statewide delivery)		
Kerosine	7	7

Prices in Effect	Sept. 5	Aug. 28
CALIFORNIA		
40-43 grav. w.w.	5 – 7	5 – 7
San Joaquin Valley:		
Heavy fuel	$1.10 (2)	$1.10 (2)
Light fuel	$1.20 (2)	$1.20 (2)
Diesel fuel	4 (2)	4 (2)
Stove dist.	5 (2)	5 (2)
Los Angeles:		
Heavy fuel	$1.10 (2)	$1.10 (2)
Light fuel	$1.20 (2)	$1.20 (2)
Diesel fuel	4 (2)	4 (2)
Stove dist.	5 (1)	5 (1)
San Francisco:		
Heavy fuel	$1.15 (2)	$1.15 (2)
Light fuel	$1.25 (2)	$1.25 (2)
Diesel fuel	4.5 (2)	4.5 (2)
Stove dist.	5.5 (1)	5.5 (1)

NOTE: All above heavy fuels meet Pacific specification 400; light fuel, spec. 300; Diesel fuels, spec. 200; and stove distillate, spec. 100.

Lubricating Oils

Prices in Effect	Sept. 5	Aug. 28
WESTERN PENNA.		
Prices are for sales made, or offers reliably reported, to jobbers & compounders only.		
Viscous Neutrals—*No. 3 col. Vis. at* 70°*F.*		
200 Vis. (180 at 100°) 420-425 fl.		
0 p.t.	38 (1)	38 (1)
10 p.t.	37 (1)	37 (1)
15 p.t.	36 (1)	36 (1)
25 p.t.	28-33	28-33
150 Vis. (143 at 100°) 400-405 fl.		
0 p.t.	36 (1)	36 (1)
10 p.t.	35 (1)	35 (1)
15 p.t.	34 (1)	34 (1)
25 p.t.	26–31	26-31

NOTE: Limited quantity neutrals available to regular trade.

Cylinder Stocks:

Brt. stk., 145-155 *vis. at* 210°, 540-550 fl., *No. 8 col.*

10 p.t.	30.5 (1)	30.5 (1)
15 p.t.	29.5 (1)	29.5 (1)
25 p.t.	25	25
600 S.R. filterable	15	15
650 S.R.	15.5	15.5
600 fl.	16	16
630 fl.	17	17

MID-CONTINENT (F. o. b. Tulsa)

Neutral Oils (*Vis. at* 100° *F. to* 10 *P.P.*)

Pale Oils:

Vis. Color		
60-85—No. 2	7.5	7.5
86-110—No. 2	7.5 – 8.5	7.5 – 8.5
150—No. 3	11 –11.5	11 –11.5
180—No. 3	11.5 –15	11.5–15
200—No. 3	12 –15	12 –15
250—No. 3	14 –16.5	14 –16.5
280—No. 3	15 –17	15 –17
300—No. 3	16 –18	16 –18

Red Oils:

180—No. 5	11.5 (1)	11.5 (1)
200—No. 5	12 (1)	12 (1)
280—No. 5	No Price	No Price
300—No. 5	16-17.5(2)	16-17.5 (2)

Bright Stock—*Vis. at* 210°

200 Vis. D	27 (1)	27 (1)
150-160 Vis. D:		
0 to 10 p.p.	23	23
10 to 25 p.p.	22.5–23	22.5–23
25 to 40 p.p.	23 (1)	23 (1)
150-160 Vis. E	22 (1)	22 (1)
120 Vis. D:		
0 to 10 p.p.	22 (2)	22 (2)
600 S.R. Dark Green	8.5 (1)	8.5 (1)
600 S.R. Olive Green	10-11 (2)	10-11 (2)
631 S.R.	....	....
Black Oil	....	....

NOTE: Discounts of 0.5c to 1c on bright stock and 0.5c to 2c allowed for neutrals, 10 car lots, and to "meet competition." Brokers offering at greater discounts.

SOUTH TEXAS (Neutral Oils)

Pale Oils (*Vis. at* 100°*F.*)

Vis. Color		
100 No. 1½-2½	6.5	6.5
200 No. 2-3	8.75	8.75
300 No. 2-3	9.25	9.25
500 No. 2½-3½	10	10
750 No. 3-4	10.25	10.25
1200 No. 3-4	10.375	10.375
2000 No. 4	10.5	10.5

(Continued on next page)

NOTE—Parenthetical figures after prices indicate number of companies quoting when less than three companies are quoting.

NOTICE—Owing to great demand, refiners generally limit quotations to regular customers and refuse bids, though higher, from others. Refiners' prices and sales shown; bids reported in market leads.

Refinery Prices (Continued)

Prices in Effect	Sept. 5	Aug. 28
Red Oils:		
100 No. 5-6	6.5 (2)	6.5 (2)
200 No. 5-6	8.75	8.75
300 No. 5-6	9.25	9.25
500 No. 5-6	10	10
750 No. 5-6	10.25	10.25
1200 No. 5-6	10.375	10.375
2000 No. 5-6	10.5	10.5

CHICAGO (From Mid-Continent p.l. crude.) Neutral oils *vis. at* 100° *F.* 0 *to* 10 *p.p.*

Pale Oils Vis. Color		
60-85—No. 2	9 (1)	9 (1)
86-110—No. 2	9.25 (1)	9.25 (1)
150—No. 3	12.5 (1)	12.5 (1)
180—No. 3	13 (1)	13 (1)
200—No. 3	13 (1)	13 (1)
250—No. 3	14 (1)	14 (1)
Red Oils:		
180—No. 5	13 (1)	13 (1)
200—No. 5	13 (1)	13 (1)
250—No. 5	14 (1)	14 (1)
280—No. 5	15 (1)	15 (1)
300—No. 5	15.5 (1)	15.5 (1)

Note: Viscous oils, 15 to 30 p.p. are quoted 0.5c lower; 60-85 and 86-110 No. 2 non-viscous oils, 15 to 30 p.p., 0.25c lower.

Unfiltered Steam Refined (*Viscosity at* 210°)		
140	11.5 (1)	11.5 (1)
160	12.5 (1)	12.5 (1)
200	13.5 (1)	13.5 (1)

Bright stocks, 160 *vis. at* 210 *No.* 8 *color*:		
0 to 10 p.p.	24 (1)	24 (1)
15 to 25 p.p.	23.5 (1)	23.5 (1)
30 to 40 p.p.	21.5 (1)	21.5 (1)
E filtered Cyl. Stock	15.5 (1)	15.5 (1)

Note: To obtain prices delivered in Chicago add 0.25c per gal.

Natural Gasoline

(Group 3 & Breckenridge prices are to blenders on freight basis shown below. Shipments may originate in any Mid-Continent manufacturing district.

FOB GROUP 3

Grade 26-70 .... 4.75 (Sales) 4.75 (Sales)

FOB BRECKENRIDGE

Grade 26-70 .... 4.375 (Quotes) 4.375 (Quotes)

CALIFORNIA (FOB plants in Los Angeles basin)

21 pound vapor pressure for blending		
	4.75 - 5.375	4.75 - 5.375

Naphtha and Solvent

(*FOB Group* 3)

Stoddard solvent	6.625	6.625
Cleaners' naphtha	7.125	7.125
V.M.&P. naphtha	7.1 - 7.125	7.1 - 7.125
Mineral spirits	6.1 - 6.125	6.1 - 6.125
Rubber solvent	7.1 - 7.125	7.1 - 7.125
Lacquer diluent	7.375- 8.125	7.375- 8.125
Benzol Diluent	7.875- 8.625	7.875- 8.625

WESTERN PENNA.

Bradford-Warren District:		
Stoddard Solvent	7.5 (1)	7.5 (1)
Other Districts:		
Untreated naphtha	7 -7.25 (2)	7 -7.25 (2)
Stoddard solvent	7.25 -7.5 (2)	7.25 -7.5 (2)

OHIO (S. O. quotations for statewide delivery):

	V.M.&P. naphtha.	D.C. naphtha, Varnolene &
Sohio solvent	10	10
Rubber solvent	9	9

Wax

WESTERN PENNA. (Bbls. C.L.)

White Crude Scale:		
122-124 A.m.p.	4.25 (2)	4.25 (2)
124-126 A.m.p.	4.25	4.25

OKLAHOMA (C.L. FOB Refinery)

Semi-refined:		
128 AMP min., white, 50 kilo bags	No Price	No Price
132-134 AMP, bbls.	5.25 (1)	5.25 (1)

CHICAGO (FOB Chicago district refinery of one refiner, in bags, carloads. Carloads, slabs loose, 0.4c less. Melting points are EMP (ASTM) methods; add 3° to convert into AMP.)

Fully refined:		
122-124 (bags only)	5.6	5.6
125-127	6	6
127-129	6.25	6.25
130-132	6.55	6.55
132-134	6.8	6.8
135-137	7.55	7.55

Petrolatums

WESTERN PENNA. (Bbls., carloads; tank cars, 0.5c per lb. less.)

Snow White	6.125- 7.25	6.125- 7.25
Lily White	5.375- 6.25	5.375- 6.25
Cream White	4.375- 5.5	4.375- 5.5
Light Amber	3.375- 4	3.375- 4
Amber	3.125- 3.75	3.125- 3.75
Red	3 - 3.5	3 - 3.5

Tank Wagon Prices

Commercial or consumer tank car, tank wagon, dealer, and service station prices for gasoline **do not include taxes**; *they do, however, include inspection fees as shown in general footnote. Gasoline taxes, shown in separate column, include* 1.5c *federal, and state taxes; also city and county taxes as indicated in footnotes. Kerosine tank wagon prices also do not include taxes; kerosine taxes where levied are indicated in footnotes. Dealer discounts are shown in footnotes. These prices in effect Sept.* 5, 1944 *as posted by principal marketing companies at their headquarters offices, but subject to later correction*

S. O. N. J. — **Esso** (*Regular Grade*)

	Consumer Tank Wagon	Dealer T.W.	Gasoline Taxes	Kerosine T.W.
*Atlantic City, N. J.	10.2	10.7	4.5	10
*Newark, N. J.	10.2	10.7	4.5	10
Annapolis, Md.	10.55	11.05	5.5	....
Baltimore, Md.	9.95	10.45	5.5	10.8
Cumberland, Md.	11.35	11.85	5.5	12.3
Washington, D. C.	10.2	10.7	4.5	11.3
Danville, Va.	11.65	12.15	6.5	12.55
Norfolk, Va.	10.45	10.95	6.5	12.3
Petersburg, Va.	10.75	11.25	6.5	13.3
Richmond, Va.	10.75	11.25	6.5	13.3
Roanoke, Va.	11.95	12.45	6.5	12.8
Charleston, W. Va.	12.25	12.75	6.5	13.6
Parkersburg, W. Va.	11.55	12.05	6.5	13.3
Wheeling, W. Va.	11.55	12.05	6.5	13.9
Charlotte, N. C.	12.1	12.6	7.5	11.6
Hickory, N. C.	12.65	13.15	7.5	12.6
Mt. Airy, N. C.	12.5	13.0	7.5	11.8
Raleigh, N. C.	11.85	12.35	7.5	12.6
Salisbury, N. C.	12.15	12.65	7.5	13.0
Charleston, S. C.	10.95	11.45	7.5	....
Columbia, S. C.	11.8	12.3	7.5	....
Spartanburg, S. C.	12.5	13.0	7.5	....

	Mineral Spirits T.W.	V.M.&P. T.W.
Newark, N. J.	13	14.5
Baltimore, Md.	15.5	....
Washington, D. C.	15.5	....

Fuel Oils—T.W.	No. 1	No. 2	No. 3
Atlantic City, N. J.	10	9	9
Newark	10	9	9
Annapolis, Md.	..	..	..
Baltimore	9.8	9	9
Washington, D. C.	10.3	9.4	9.4
Norfolk, Va.	10	8.8	8.8
Petersburg	10.3	9	..
Richmond	10.3	9	9
Charlotte, N. C.	10.6	10.4	..
Hickory, N. C.	..	10	..
Raleigh	11.6	10.1	..
Charleston, S. C.	..	9	..
Columbia	..	10	..
Spartanburg	..	10.8	..

*Effective Aug. 5, '42 minimum retail resale price of 14.2c posted thru New Jersey.

Discounts:

Esso gasoline—to undivided dealers, 0.5c off dealer t.w.

Kerosine—1c off t.w. price for 25 gals. or more, under contract thru territory (Baltimore city contract not necessary) except no discount in state of New Jersey.

Naphtha—To buyers taking following quantities at one time: Newark, 2c per gal. on 200 gals. or more, less than 200 gals. 0.5c higher price; Baltimore, 2c off on 25 to 100 gals. and 3c on over 100 gals.; Washington, 2c off to contract buyers.

Notice

These prices include inspection fees on both gasoline and kerosine unless otherwise specified per gallon as follows:

Ala. 1/40c on gasoline; Ark. 1/20c; Fl. 1/8c; Ill. 3/100c; Ind. 1/5c in lots of 25 bbls. or less, 2/25c in lots of more than 25 bbls.; Kans. 1/50c; La. 1/32c; Minn. 7/200c; Miss. 1/50c; Neb. 3/100c; Nev. 1/20c; N. C. 1/4c; N. Da. 1/20c; Okla. 2/25c; S. Car. 1/8c; S. Da. 1/20c; Tenn. 2/5c; and Wisc. 3/100c.

Kerosine inspection fees only: Ala. 1/2c; Fla. 1/8c; Iowa 3/50c; Mich. 1/5c per gal.

CONT'L OIL

	†Tank Wagon	Conoco Bronz-z-z (*3rd Grade*)	Demand Gasoline Taxes	Kerosine T.W.
Denver, Col.	10	9	5.5	10
Grand Junc., Col.	12.5	11.5	5.5	12.5
Pueblo, Col.	9.5	8.5	5.5	9.5
Casper, Wyo.	11.5	10.5	5.5	12
Cheyenne, Wyo.	10	9	5.5	9
Billings, Mont.	12	11	6.5	12.5
Butte, Mont.	11.5	10.5	6.5	13.5
Great Falls, Mont.	12	11	6.5	12.5
Helena, Mont.	12	11	6.5	13
Salt Lake City, Utah	13.5	12.5	5.5	14.5
Boise, Ida.	13.6	12.6	6.5	16.5
Twin Falls, Ida.	14.6	13.6	6.5	17
Albuquerque, N. M.	10.5	9.5	*7	9.5
Roswell, N. M.	10	9	*7	7
Santa Fe, N. M.	10.5	9.5	*7.5	10
Ft. Smith, Ark.	9	6.25	*7	8
Texarkana, Ark.	9	7.5	*5.5	7
Muskogee, Okla.	7.75	6.75	7	8
Oklahoma City, Okla.	8	7	7	8
Tulsa, Okla.	8	7	7	8

*Taxes: In gasoline tax column are included these city taxes—Albuquerque, & Roswell, 0.5c, Santa Fe, 1c. Texas 4c state tax applies within city limits of Texarkana, Ark.; Okla., 5.5c state applies within city limits of Ft. Smith, Ark.

†To Consumers & Dealers.

NOTE: Current selling price—where this is lower than maximum price it is because of local competition. It is the actual selling price and is subject to revision due to delays in receiving information from the field.

S. O. NEB.

	(*Regular Grade*) T.W.	Dealer	Gasoline Taxes	Kerosine T.W.
Omaha	11.4	9.6	6.5	10.1
McCook	12.0	10.1	6.5	10.5
Norfolk	11.9	10.4	6.5	10.6
North Platte	12.2	10.6	6.5	11
Scottsbluff	12.9	10.2	6.5	10.5

S. O. CAL.

Standard Gasoline (*Regular Grade*)
Flight Gasoline (*Third Grade*)

	Standard Posted Net Tank Truck	Standard Posted Retail	Flight Posted Net Tank Truck	Flight Posted Retail	Gasoline Taxes
San Francisco, Cal.	10	14	9	12	4.5
Los Angeles, Cal.	9.5	13.5	8.5	11.5	4.5
Fresno, Cal.	11	15	10	13	4.5
Phoenix, Ariz.	12	16	10	13	6.5
Reno, Nev.	12	16	11	14	5.5
Portland, Ore.	10.5	14.5	9.5	12.5	6.5
Seattle, Wash.	10.5	14.5	9.5	12.5	6.5
Spokane, Wash.	12.5	16.5	11.5	14.5	6.5
Tacoma, Wash.	10.5	14.5	9.5	12.5	6.5

Std. Aviation 73

	Posted Net Tank Truck	Gasoline Taxes	Kerosine Tank Truck
San Francisco, Cal.	12.5	4.5	11.5
Los Angeles, Cal.	12	4.5	10
Fresno, Cal.	13.5	4.5	12.5
Phoenix, Ariz.	14.5	6.5	12.5
Reno, Nev.	14.5	5.5	13.5
Portland, Ore.	13	6.5	13.8
Seattle, Wash.	13	6.5	13.8
Spokane, Wash.	16	6.5	16.8
Tacoma, Wash.	13	6.5	13.8

Resale & Commercial: T.C. deliveries 0.25c per gal. off posted net tank truck.

Commercial: Retail deliveries, and/or tank truck deliveries of less than 40 gals., 4c per gal. above posted net tank truck price for Standard Aviation and Standard Gasoline, and 3c per gal. above posted net tank truck for Flight Gasoline, except single deliveries of less than 40 gals. to Marine trade only, which are billed at posted net tank truck price.

TEXAS CO.

	Gasoline—Dealer T.W. Fire-Chief (*Regular*)	Indian (*3rd Grade*)	Gasoline Taxes
Dallas, Tex.	7.5	6.5	5.5
Ft. Worth, Tex.	7.5	6.5	5.5
Wichita Falls, Tex.	8.5	7.5	5.5
Amarillo, Tex.	8.5	7.5	5.5
Tyler, Tex.	8.5	7.5	5.5
El Paso, Tex.	11	10.5	5.5
San Angelo, Tex.	8.5	7.5	5.5
Waco, Tex.	8.5*	7*	5.5
Austin, Tex.	8.5	7.5	5.5
Houston, Tex.	8.5	7.5	5.5
San Antonio, Tex.	8.5	7.5	5.5
Port Arthur, Tex.	8.5	7.5	5.5

*Less 1c temporary allowance to all dealers.

(Continued on next page)

Tank Wagon Prices—Continued

S. O. IND.

	Red Crown Blue Crown (*Regular Grade*) Red Dealer Prices Crown Cons. T.W.	Red Crown	Blue Crown (*Third Grade*)	Gasoline Taxes	Kerosine T.W.
Chicago, Ill.	11.6	9.6	9.1	4.5	10.6
Decatur, Ill.	11.6	9.6	8.7	4.5	10.3
Joliet, Ill.	11.9	10.3	9.2	4.5	10.6
Peoria, Ill.	11.7	9.9	9.7	4.5	10.4
Indianapolis, Ind.	11.6	10.1	9.6	5.5	10.1
Evansville, Ind.	11.4	9.9	8.6	5.5	9.9
South Bend, Ind.	12	10.5	10	5.5	10.5
Detroit, Mich.	11.4	9.9	9.4	4.5	10
Grand Rapids, Mich.	11.4	9.9	9.4	4.5	9.9
Saginaw, Mich.	11.4	9.9	9.4	4.5	9.9
Green Bay, Wis.	12.2	10.7	10.2	5.5	10.9
Milwaukee, Wis.	12.1	10.6	10.1	5.5	10.8
La Crosse, Wis.	11.9	10.4	9.9	5.5	10.6
Minneapolis - St. Paul.	11.9	10.4	9.9	5.5	10.6
Duluth, Minn.	12.2	10.7	10.2	5.5	10.9
Mankato, Minn.	11.9	10.4	9.9	5.5	10.6
Des Moines, Ia.	11.4	9.9	9.4	4.5	*10.1
Mason City, Ia.	11.7	10.2	9.7	4.5	*10.4
St. Louis, Mo.	11.0	9.5	9.3	*4.5	10.1
Kansas City, Mo.	11.0	9.5	8.6	*4.5	9.7
St. Joseph, Mo.	11.2	9.7	9.2	*4.5	9.9
Fargo, N. D.	12.9	11.4	10.9	5.5	11.6
Huron, S. D.	12.3	10.8	10.3	5.5	11
Wichita, Kans.	10.3	8.8	7.2	4.5	9.0

Stanavo Aviation 73 Octane

Withdrawn Jan. 1, 1944.

	Oleum Spirits	V.M.&P. Naphtha	Stanisol	*Taxes
(Prices are base prices before discounts)				
Chicago	13.5	13.8	12.8	4.5
Detroit	15.8	15	16.3	4.5
K. C., Mo.	13.3	14.3	13.8	1.5
St. Louis, Mo.	13.7	14.7	13.2	1.5
Milwaukee	14.4	15.4	14.9	5.5
Minnep'ls	14.2	15.2	13.5	5.5

Fuel Oils T.W.

Chicago

	Standard Heater Oil
1-99 gals.	9.3
100-149 gals.	8.3
150 gals. & over	7.8

	Stanolex Furnace Oil
1-99 gals.	8.8
100-149 gals.	7.8
150-399 gals.	7.8
400 gals. & over	7.3

	Stanolex Fuel A
1-749 gals.	6.5
750 gals. & over	5.75

	Stanolex Fuel C
1-749 gals.	6.0
750 gals. & over	5.25

Other Points	Stanolex Furnace Oil
Indianapolis	
1-99 gals.	9.0
100 gals. & over	8.0
Detroit	
1-99 gals.	8.7
100 gals. & over	7.7
Milwaukee	
1-99 gals.	9.0
100 gals. & over	8.0
Minneapolis	
1-99 gals.	9.1
100 gals. & over	8.1
St. Louis	
1-99 gals.	8.4
100 gals. & over	7.4
Kansas City	
1-99 gals.	8.1
100 gals. & over	7.1

*Taxes: In gasoline tax column are included these city taxes—Kansas City, St. Joseph and St. Louis, 1c. Iowa kerosine prices are ex 3c state tax. In naphtha tax column are included 1.5c federal tax and state taxes.

State sales, occupation, consumer and use taxes to be added when applicable.

HUMBLE OIL

Humble Motor Fuel (*Regular Grade*)

	Thriftane Humble *Tank Wagon	Thriftane Humble Retail	(*Third Grade*) Thriftane *Tank Wagon	Thriftane Retail	Gasoline Taxes
Dallas, Tex.	7.5	10.5	6.5	10.5	5.5
Ft. Worth, Tex.	6.5	9.5	6	7.5	5.5
Houston, Tex.	8.5	12.5	7.5	10.5	5.5
San Ant., Tex.	8.5	12.5	7.5	10.5	5.5

	Kerosine *Tank Wagon	Kerosine Retail
Dallas, Tex.	7	10
Ft. Worth, Tex.	7	11
Houston, Tex.	8	11
San Antonio, Tex.	7	10

*To all classes of dealers & consumers.

S. O. OHIO

***Sohio X-70 Gasoline (*Regular Grade*)**

	Consumer T.W.	**Resellers	‡S.S.	Gasoline Taxes	†Kerosine T.W.
Ohio, Statewide	12	10	13.5	5.5	9.3
Akron	12	9.5	12.5	5.5	9.3
Canton	12	9.5	12.5	5.5	9.3
Cincinnati	12	9.5	12.5	5.5	9.3
Cleveland	12	9.5	12.5	5.5	9.3
Columbus	12	9.5	12.5	5.5	9.3
Dayton	12	9.5	12.5	5.5	9.3
Lima	12	9.5	12.5	5.5	9.3
Mansfield	12	9.5	12.5	5.5	9.3
Marion	12	9.0	12.0	5.5	9.3
Portsmouth	12	9.5	12.5	5.5	9.3
Toledo	12	9.5	12.5	5.5	9.3
Youngstown	12	9.5	12.5	5.5	9.3
Zanesville	12	9.5	12.5	5.5	9.3

Aviation Gasoline—Statewide

	Consumer Gasoline T.W.	Taxes
Sohio Aviation Gasoline clear	14.5	5.5
Spec. AN-F-22	14.5	5.5
Esso Ethyl Aviation 73 Oct.	15.5	5.5
Esso Ethyl Aviation 80 Oct.	16.5	5.5
Esso Ethyl Aviation 87 Oct.	17.5	5.5
Esso Ethyl Aviation 91 Oct.	17.5	5.5
Esso Ethyl Aviation 100 Oct.	24.5	5.5

	†Naphtha—T.W. Statewide	Lucas County
S. R. Solvent	13.5	13.5
D. C. Naphtha	14.5	14.25
V.M.&P. Naphtha	14.5	14.25
Varnolene	14.5	14.25
Sohio Solvent	14.5	14.25

Fuel Oils—T.W.	No. 1	No. 2	No. 3	No. 4
Ohio, Statewide	8.3	8.3	7.8	*7.55

*Renown (third-grade) prices are same as X-70 unless otherwise noted.

**Except authorized agents.

†Kerosine prices are ex 1c state tax. Naphtha prices are ex 1.5c federal & 4c state tax.

‡Prices at company-operated stations.

††Statewide prices are subject to exceptions other than those shown.

Discounts:

Esso aviation—on contract to hangar operators and resellers, 2c off consumer t.w.

*For Cleveland area only. Full compartment hose dumps.

Fuel oils—Statewide prices are for t.w. & drum deliveries of 50 gals. or more; prices for deliveries of less than 50 gals. are 0.5c higher.

Naphthas—to contract consumers off t.w prices—Statewide: 300 to 999 gals., 0.5c; 1000 to 2499 gals., 0.75c; 2500 to 4999 gals., 1c; 5000 or more gals., 1.5c. Lucas County: Less than 50 gals., tank wagon price, 50 to 249 gals., 0.5c; 250 to 499 gals., 1c; 500 gals. or over, 1.5c.

Canada

PRICES OF IMPERIAL OIL, LTD.

Per Imperial Gallon, which is 1.2 U. S. Gallons

IMPERIAL OIL

3-Star Imperial Gasoline (*Regular Grade*)

	†Gasoline T.W.	*Gasoline Taxes	Kerosine T.W.
Hamilton, Ont.	17.5	11	18
Toronto, Ont.	17.5	11	18
Brandon, Man.	21	10	23
Winnipeg, Man.	20.5	10	22.5
Regina, Sask.	18	10	20
Saskatoon, Sask.	20.8	10	22.8
Edmonton, Alta.	18.9	10	20.9
Calgary, Alta.	16	10	18
Vancouver, B. C.	15	10	24
Montreal, Que.	17	11	17.5
St. John, N. B.	16.5	13	19
Halifax, N. S.	16.5	13	19

*Includes 3c Federal, and Provincial taxes.

To divided & undivided dealers.

Absorption Gasoline—No. 26 R.V.P.—$2.28

ATLANTIC REFINING

Atlantic White Flash (*Regular Grade*)

	Commercial T.W.	Dealer T.W.	Gasoline Taxes	Kerosine T.W.
Philadelphia, Pa.	10.2	10.7	5.5	12.25
Pittsburgh	10.7	11.2	5.5	12.6
Allentown	10.7	11.2	5.5	12.6
Erie	10.7	11.2	5.5	12.6
Scranton	10.7	11.2	5.5	12.6
Altoona	10.7	11.2	5.5	12.6
Emporium	10.7	11.2	5.5	12.6
Indiana	10.7	11.2	5.5	12.6
Uniontown	10.7	11.2	5.5	12.6
Harrisburg	10.7	11.2	5.5	12.6
Williamsport	10.7	11.2	5.5	12.6
Dover, Del.	....	11.2	5.5	12.6
Wilmington, Del.	....	10.7	5.5	12.1
Boston, Mass.	....	10.9	4.5	....
Springfield, Mass.	....	11.8	4.5	....
Worcester, Mass.	....	11.5	4.5	....
Fall River, Mass.	....	11	4.5	....
Hartford, Conn.	....	11.6	4.5	....
New Haven, Conn	....	11	4.5	....
Providence, R. I.	....	11	4.5	....
Atlantic City, N. J.	....	10.7	4.5	10
Camden, N. J.	....	10.7	4.5	10
Trenton, N. J.	....	10.7	4.5	10
Annapolis, Md.	....	11.05	5.5	10.8
Baltimore, Md.	....	10.45	5.5	9.8
Hagerstown, Md.	....	11.55	5.5	10.3
Richmond, Va.	....	11.25	6.5	12.3
Wilmington, N. C.	....	11.55	7.5	11.9
Brunswick, Ga.	....	10.4	7.5	11.1
Jacksonville, Fla.	....	10.4	8.5	12.1

	Mineral Spirits T.W.†	V.M.&P. T.W.†
Philadelphia, Pa.	11	12.5
Lancaster, Pa.	12	13.5
Pittsburgh, Pa.	12.5	13.5

	Fuel Oils—T.W. 1	2	3	5	6*
Phila., Pa.	10.1	9	9	5.76	5.04*
Allentown, Pa.	10.6	9.3	9.3	....	....
Wilmington, Del.	10.1	9	9	....	....
Springfield, Mass.	10.2	9.4	9.4	....	....
Worcester, Mass.	10.2	9.3	9.3	....	....
Hartford, Conn.	10.5	9.2	9.2	....	....

‡Does not include 1c Georgia kerosine tax.

†Mineral Spirits prices also apply to Stoddard Solvent; V.M.&P. prices also apply to Light Cleaners Naphtha.

Discounts:

Gasoline—to undivided dealers, 0.5c off dealer t.w. except Georgia & Florida dealer t.w. and undivided dealer t.w. prices are same.

Kerosine—Thru Penna. & Delaware, 2c off t.w. price on t.w. deliveries of 25 gals. or more at one time.

*Residual fuel 13.0-15.9 gravity effective 10/17/43.

S. O. KY.

Crown Gasoline (*Regular*) Standard (*Third Grade*)

	†Net Crown	Gasoline Taxes	Kerosine T.W.
Covington, Ky.	9.5	6.5	9.3
Lexington, Ky.	10.5	6.5	9.3
Louisville, Ky.	10	6.5	8.8
Paducah, Ky.	10	6.5	8.8
Jackson, Miss.	10	7.5	*9
Vicksburg, Miss.	9.5	7.5	*8.5
Birmingham, Ala.	10	*8.5	9
Mobile, Ala.	9	*9.5	8.5
Montgomery, Ala.	10	*9.5	*10
Atlanta, Ga.	11.4	7.5	*12.1
Augusta, Ga.	11.4	7.5	*11.6
Macon, Ga.	11.4	7.5	*12.1
Savannah, Ga.	10.4	7.5	*11.1
Jacksonville, Fla.	10.4	8.5	10.1
Miami, Fla.	10.4	8.5	10.1
Pensacola, Fla.	9	*9.5	8
Tampa, Fla.	10.4	8.5	10.1

*Taxes: In tax column are included these city and county gasoline taxes: Mobile, 2c city; Birmingham, 1c city; Montgomery, 1c city and 1c county; Pensacola, 1c city. Georgia and Montgomery, Ala. have 1c kerosine tax, Mississippi 0.5c, included in above prices.

†Consumer t.w. prices are same as net dealer prices.

S. O. LA.

Esso Gasoline (*Regular Grade*)

	Consumer Tank Wagon	Dealer T.W.	Gasoline Taxes	Kerosine T.W.
New Orleans, La.	8.75	9.25	8.5	*9
Baton Rouge, La.	8.75	9.25	8.5	*9.5
Alexandria, La.	8.75	9.25	8.5	*9.5
Lafayette, La.	9	9.5	8.5	*9
Lake Charles, La.	9	9.5	8.5	*11
Shreveport, La.	8.5	9	8.5	*8
Knoxville, Tenn.	10.5	11	8.5	12.5
Memphis, Tenn.	8.90	9.40	8.5	10.5
Chattanooga, Tenn.	10.5	11	8.5	11
Nashville, Tenn.	10.5	11	8.5	10
Bristol, Tenn.	10.95	11.45	8.5	13.1
Little Rock, Ark.	9.5	10	8	10

*Louisiana kerosine prices are ex 1c state tax.

Discounts:

Esso Gasoline—To undivided dealers, 0.5c off dealer t.w.

(Continued on next page)

Seaboard Export Coastwise Prices

Atlantic Coast

(Prices are of refiners, FOB their refineries & their tanker terminals, & of tanker terminal operators FOB their terminals)—Prices in Effect Sept. 5.

Pacific Export

In Ship's Bunkers, or deep tank lots:

Prices in Effect	Sept. 5	Aug. 28
Diesel Fuel, Pac. Spec. 200	$1.45	$1.45
Grade C fuel, Pac. Spec. 400	$1.10	$1.10

District	MOTOR GASOLINE 72 Oct. (ASTM)	70-74 oct. (ASTM)	KEROSINE and /or NO. 1 FUEL	FUEL OILS No. 2	No. 3	No. 5	No. 6
N. Y. Harb.	Not made	9.075– 9.2	7.1	6.7	6.7	$1.85	$1.77
N. Y. Harb., barges	"	8.975	7	6.6	6.6	....	....
Albany	"	9.175– 9.3	7.3	6.8	6.8 (2)	....	$1.97 (1)
Philadelphia	"	9.075– 9.2	7.2	6.7	6.7	$1.98	$1.77
Baltimore	"	8.825– 8.95	7.2	6.7	6.7	$1.85 (1)	$1.77
Norfolk	"	8.575– 8.825	7.1	6.7	6.7 (1)	$1.85 (1)	$1.77
Wilmington, N. C.	"	8.575– 8.7	7.05	6.7	....	....	....
Charleston	"	8.575–8.7 (a)	7.2	6.7 (2)	....	$1.80 (1)	$1.72 (2)
Savannah	"	8.125– 8.4	7.05	6.25 (1)	....	....	$1.72 (1)
Jacksonville	"	8.145– 8.275	7.05 (2)	6.25	....	....	$1.72
Miami	"	8.145-8.275(2)	7.05	6.25 (1)	....	....	....
Tampa	"	8.145– 8.275	7.05	6.25	....	....	$1.62
Pensacola	"	6.875–7.075 (1)	4.8 (1)	....	....	....	....
Mobile	"	6.62 – 7.075	4.75 (2)	....	....	....	....
New Orleans	"	6.125-6.375(2)	4.25 – 4.75	3.75 (2)	....	$1.27 (1)	$0.97
Portland	"	9.375– 9.5	7.3	6.8	6.8 (2)	....	$1.77
Boston	"	9.275– 9.4	7.2	6.7	6.7 (2)	$1.95 (2&b)	$1.77
Providence	"	9.275– 9.4	7.2	6.7	6.7 (2)	$1.90 (1)	$1.77

NOTE: To conform with Article IV of MPR 88 as amended Aug. 15 we are substituting 70-74 oct. ASTM for the old 72-74 oct. ASTM. We continue to include in this group, Housebrand quotations.

(a) Correct on and since Aug. 15. (b) Correct on and since Aug. 1.

Tank Wagon Prices (Continued)

SOCONY VACUUM

	Socony Mobilgas (*Regular Grade*) Com. Cons. T.W.	Undiv. Dlr. T.W.	Gasoline Taxes
New York City			
Manhattan & Bronx	10.1	10.6	*5.5
Kings & Queens	10.1	10.6	*5.5
Richmond	9.7	10.2	*5.5
Albany, N. Y.	9.9	10.4	5.5
Binghamton, N. Y.	11	11.5	5.5
Buffalo	10.2	10.7	5.5
Jamestown, N. Y.	10.4	10.9	5.5
Mt. Vernon, N. Y.	10.1	10.6	5.5
Plattsburg, N. Y.	11	11.5	5.5
Rochester, N. Y.	10.8	11.3	5.5
Syracuse, N. Y.	10.5	11	5.5
Bridgeport, Conn.	10	10.5	4.5
Danbury, Conn.	10.5	11	4.5
Hartford, Conn.	10.6	11.1	4.5
New Haven, Conn.	10	10.5	4.5
Bangor, Me.	10.7	11.2	5.5
Portland, Me.	10.3	10.8	5.5
Boston, Mass.	9.9	10.4	4.5
Concord, N. H.	11.4	11.9	5.5
Lancaster, N. H.	12	12.5	5.5
Manchester, N. H.	11.3	11.8	5.5
Providence, R. I.	10	10.5	4.5
Burlington, Vt.	10.9	11.4	5.5
Rutland, Vt.	11	11.5	5.5

	Mineral Spirits T.W.	V.M.&P. T.W.
Buffalo, N. Y.	12.4	13.6
New York City	11	12
Rochester, N. Y.	13.2	14.4
Syracuse, N. Y.	14	....
Boston, Mass.	12	13
Bridgeport, Conn.	†16.3	†17.3
Hartford, Conn.	†16.3	†17.3
Providence, R. I.	13	14

	Kerosine Yard	Kerosine T.W.	Mobilfuel Diesel T.C.	Mobilfuel Diesel T.W.	Mobilheat Fuel Yard	Mobilheat Fuel T.W.
New York:						
Manhat'n & Bronx	7.5	10.3	...	9.3	7.1	9
Kings & Queens	7.5	10.3	...	9.3	7.1	9
Richmond	7.5	10.3	...	...	7.1	9.0
Albany	7.5	9.8	6.8	9.3	7	9
Binghamton	8.9	11.2	...	10.7	8.4	10.2
Buffalo	8.6	10.9	8	10.3	8.2	10
Jamestown	8.7	11	...	10.6	8.3	10
Mt. Vernon	7.6	10.3	...	9.4	7.2	9
Plattsburg	8.1	10.4	...	9.9	7.6	9.4
Rochester	8.7	11	7.9	10.2	7.9	9.7
Syracuse	8.5	10.8	7.8	10.1	7.8	9.6
Conn.:						
Bridgeport	7.8	10.3	...	....	7.4	9.0
Danbury	8.2	10.8	...	....	7.8	8.8
Hartford	8.0	10.5	...	9.5	7.4	9.2
New Haven	7.5	10.3	...	9.3	7.1	9.0
Maine:						
Bangor	7.9	10.2	7.4	9.7	7.4	9.1
Portland	7.5	10.2	6.8	9.3	7	9
Mass.:						
Boston	7.8	10.6	6.7	9.2	7.1	9
N. H.:						
Concord	8.4	10.7	...	....	8.2	10
Lancaster	9.5	11.8	...	....	9.2	11
Manchester	8.5	11.1	...	....	7.9	9.7
R. I.:						
Providence	7.8	10.1	6.7	9.2	7.1	9.0
Vermont:						
Burlington	8.1	10.4	7.5	9.8	7.5	9.2
Rutland	8.3	10.6	...	10	7.7	9.5

*Does not include 1% city sales tax applicable to price of gasoline (ex tax).

†In steel barrels.

Discounts: Diesel—On t.w. deliveries, 0.5c for at least 400 gals.; 1c for full tank truck.

	Bunker C Fuel Ships' bunkers (Ex Lighterage)	Diesel Oil Ships' bunkers (Ex Lighterage)	Diesel Oil Shore Plants	Gas House Gas Oil 28-34 Gravity
N. Y. Harbor	$1.77	$2.78	6.7–6.8 (2)	6.8 (2)
Albany	$1.97 (1)	$2.98 (1)	7 (1)	7 (1)
Philadelphia	$1.77	$2.78	....	....
Baltimore	$1.77	$2.78	6.7 (1)	6.7 (1)
Norfolk	$1.77	$2.78	6.7 (1)	6.7 (1)
Charleston	$1.72 (2)	$2.78 (2)	6.7 (1)	6.7 (1)
Savannah	$1.72 (1)	$2.62 (1)	....	....
Jacksonville	$1.72	$2.62 (2)	....	....
Tampa	$1.62	$2.62	....	....
New Orleans	$0.97	$1.65 (1)	4 (1)	....
Portland	$1.77	$2.86 (2)	7 (1)	6.9 (1)
Boston	$1.77	$2.78	6.7 (2)	6.8 (2)
Providence	$1.77	$2.78 (2)	6.9 (1)	6.8 (1)

Residual fuel prices generally vary with A.P.I. specifications from range low for 9.9 & below degrees to range high for 25.0 & above.

Bunker "C" when from Navy storage at New York and Norfolk to W.S.A. ships .05c discount.

Gulf Coast

Prices in Effect Sept. 5

MOTOR GASOLINE	New Orleans & Lower Mississippi to Baton Rouge Tank Cars	New Orleans & Lower Mississippi to Baton Rouge Barges	Texas Gulf Coast South of New Orleans Tank Cars	Texas Gulf Coast South of New Orleans Barges	CARGOES Domestic & Export From all Gulf Ports
Leaded (oct. by ASTM)					
76 oct.	6.75	6.5	6.5 – 6.75	6.75	6.75
70-74 oct.	6 – 6.25	5.625	5.625–6.375 (a)	5.625	5.625– 5.75
63-65 oct.	....	....	....	....	....
Unleaded 70 oct.	....	....	....	....	5.75
67-68 oct.	....	....	....	....	5.5
65 oct.	....	....	....	....	5.25
60 oct.	....	....	....	....	5
KEROSINE & LIGHT FUELS					
41-43 w.w. kero.	4.125– 4.25	4.125	4.125– 4.25	4.125	4.125
42-44 w.w. kero.	....	....	4.125	4.125	4.125
No. 2 fuel oil	3.75	3.75	3.75 – 4	3.75	3.75
DIESEL & GAS OILS					
(In diesel index No.)					
Below 43 di.	....	....	....	....	....
43-47 di.	....	....	....	....	4
48-52 di.	4	4	4	....	4
53-57 di.	4.125	....	4.125	4.125	4.125
58 and above	4.25	....	4.25	....	4.25

(a) 5.625c for Dist. 1 and 5.875–6.375c for other districts.

NOTE: Above products in Truck Transports of 2,400 gal. and over ½c above Tank Car Prices.

Heavy Fuels & Bunker Oil (at all Gulf Ports) Heavy Diesels	In Cargoes	In Ship's Bunkers (Ex Lighterage)
Below 28 API Grav.	....	$1.35
28 & above API Grav.	....	$1.65
Bunker C Oil	$0.97 (a)	$0.97

NOTE—Prices for heavy fuels vary within the range given above according to gravity from range low 9.9B gravity to range high 25B and above.

(a) Effective Aug. 1.

Mid-Continent Lubes

(At Gulf; in packages, FAS.; in bulk, FOB terminals).

Prices in Effect Sept. 5

	Steel Drums	Bulk
Bright Stock		
D color, Vis at 210°		
200 vis.	....	....
150 vis., 0-10 p.p.	....	32.65(1&A)
100 vis., 0-10 p.p.	....	....
100 vis., 10-25 p.p.	....	....
Neutral—No. 3 color		
200 vis., 0-10 p.p.	....	....

(A) FAS at New Orleans.

Wax

(Melting points are AMP, 3° higher than EMP. Prices are FOB refinery and do not include bag, freight or export differentials).

Prices in Effect Sept. 5

Crude Scale	New Orleans Export	N. Y. Domestic	N. Y. Export
124-6 Yellow	4.25(1)	....	4.25(1)
122-4 White	....	4.25(2)	4.25(2)
124-6 White	4.25(1)	4.25	4.25
Fully Refined:			
123-5	5.2(1)	5.2(2)	5.2(1)
125-7	5.2(1)	5.2(2)	5.2(1)
128-30	5.6(1)	5.6	5.6(1)
130-32	5.85(1)	5.85(2)	5.85(1)
133-5	6.15(1)	6.15	6.15(1)
135-7	6.4(1)	6.4(1)	6.4(1)

Naphtha

Prices in Effect Sept. 5

	V.M.&P. Naphtha	Mineral Spirits
New York Harbor	11 (2)	10
Philadelphia	11 (2)	10
Baltimore	10.5 (2)	9.5
Boston	11.5 (2)	10.5
Providence	11.5 (1)	10.5 (2)

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Phone Main 7667

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EXPERIENCED OPERATOR of 3-C and 1-C anti-knock engines seeking new connection. Draft exempt. Box No. 450, National Petroleum News.

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PETROLEUM ENGINEER to manage Oil Reclaiming Plant, with excellent postwar prospects. Write P.O. Box 344, North Tonawanda, New York.

WANTED: Refinery Instrument Repairman. Leeds-Northrup, Foxboro, Brown and Fisher Controls. Must have had 10 years experience. Permanent job, 48 hours per week. Box No. 449, National Petroleum News, Cleveland, Ohio.

DISTRICT MANAGER WANTED: We want an energetic man with sales experience for an administrative position managing our filling stations in eastern Pennsylvania. Vacancy now. Another opening in Southern territory later. Prefer man not over forty. Good salary, automobile furnished and expenses. Likely applicants will be interviewed at a city near your locality. Write: Spur Distributing Co., Inc., "Personnel", Box 941, Nashville, Tenn.

WANTED

Man to run lubricating oil re-refining plant now operating on Aircraft Run-Up Oil for Air Corps. Permanent for dependable, experienced operator. Applications treated in strictest confidence.

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ABOUT OIL PEOPLE

E. E. Williams, who was in the Detroit division of Shell Oil Co. for 14 years in connection with the distribution of liquefied petroleum gases, has been transferred to Shell's New York office. His new position will be field assistant to **F. B. Boice** in LP-gas activities for the Shell Oil Co.

° ° °

Mr. McCobb

Standard Oil Co. (N.J.) last week announced the retirement of **Thomas C. McCobb,** comptroller, and member of its board of directors since 1935.

Mr. McCobb, who was born in 1883, entered the oil business in 1902 as a freight clerk for the Atlantic Refining Co. at that time a Jersey Standard affiliate. In 1913 he joined the Standard Oil Co. of New Jersey as an accountant in the Baltimore office, moving later to the marketing division in Charlotte, N. C., and then to the manufacturing department here.

Soon after his arrival in New York, Mr. McCobb was assigned to set up a system of accounting for the company's newly acquired affiliate, the International Petroleum Co., Ltd., and visited Peru, where the company had extensive interests. In 1917 he was made assistant secretary and assistant treasurer of International, in Toronto, Canada, and he later became secretary and treasurer of Imperial Oil, Ltd.

Mr. McCobb returned to New York in 1928 as assistant comptroller of Standard Oil Co. (N.J.), and was appointed comptroller in 1933. Two years later he was elected to the board of directors and was appointed an alternate member of the executive committee.

He has traveled much throughout the Western Hemisphere and in Europe on Jersey business. He is a recognized authority on accounting, and in 1943 was elected president of the Comptrollers Institute of America.

° ° °

Philip D. Denton, executive assistant to **W. W. Vandeveer,** PAW director in charge of Dist. 2 at Chicago, is the vest button popping papa of a brand new eight pound and five ounce baby girl. Her name is **Carol.** She was born on Sept. 1, and is a third child. **Philip, Jr.,** is 10, and **Margaret** is 4.

° ° °

Chicago Oil Men's Club has announced Sept. 27 as the date for their annual autumn golf tournament and party. It will be held at Rolling Green Country Club on west side Chicago. **M. W. Prellberg,** entertainment committee, appears determined to outshine all his predecessors by arranging for special professional entertainment and refreshments, and warning out-of-town participants that they had better get their reservations in early.

° ° °

C. H. Conway, formerly in Amerada Petroleum Corp.'s Lafayette, La., land office, is in charge of the land and geological office the company is opening at Jackson, Miss.

° ° °

R. M. Hunt, former production superintendent of the Pickens district, is new district superintendent for Carter Oil Co., with headquarters at the company's newly established district production offices in Vicksburg, Miss. This new district is a part of Carter's southern division, headquarters of which are in Shreveport, La.

° ° °

New vice president and head of exploration and research for the Carter Oil Co., is **Harold F. Moses.** He has been manager of exploration with Carter since May, 1941. He joined the company in 1934 as a geologist. Since 1938 he has been assistant manager of exploration and chief geologist.

° ° °

Lester F. Danforth, Tulsa, Okla., has been promoted to captain in the Quartermaster Corps.

Capt. Danforth was formerly in charge of materials and warehouses for the Halliburton Oil Well Cementing Co., Duncan, Okla. He is now on duty in the Administrative Branch of the Fuels & Lubricants Division of the Office of The Quartermaster General. He was assigned to the anti-aircraft Artillery in May, 1943, with the rank of First Lieutenant (Reserve) after being promoted from 2nd Lieutenant in the Reserve in 1932. He was detailed to the Office of The Quartermaster General, Washington, D. C., in February, 1944.

° ° °

Sergt. Elizabeth Lamar, formerly of the Houston refinery of Shell Oil Co., was the first woman to enter the barracks in Honolulu, Hawaii, when the first WAC company to be sent to the Pacific theatre arrived there. The Air-Wacs at the Honolulu base are replacing men who are being sent to more advanced Pacific bases.

° ° °

Dr. G. S. Dille has left his practice as a consulting geologist to become manager of the land and geological department of Deep Rock Oil Corp., Sept. 1. After receiving his doctor's degree from the University of Iowa in 1929, he became associated with The Texas Co. as geologist, remaining until 1936 when he resigned to enter private practice. He is a member of the American Assn. of Petroleum Geologists, A.I.M.M.E., and a past president of both the Tulsa Geological Society and Tulsa Stratigraphic Society.

° ° °

S. B. Eckert, vice president of Sun Oil Co., recently announced appointments and transfers in the company as follows:

R. D. Drysdale becomes assistant regional manager of the Middle Atlantic region. He is succeeded by **C. Hamilton Wright** as Southeastern regional manager with headquarters in Jacksonville, Fla. **W. J. Roope** has been transferred from district manager at Toledo, Ohio, to a special assignment in the Cleveland district.

Other personnel changes recently announced in Sun's home office Industrial Products department include the appointment of **Albert E. Aldridge, Jr.,** as sales promotion manager, and **Dr. E. S. Ross** as technical representative. Mr. Aldridge in addition to his duties of handling industrial advertising, will assume responsibility for industrial market studies and analyses.

Dr. Ross, former assistant manager of the Development division, Manufacturing department, has returned to the home office, after having been on detached service with PAW since May 1, 1943.

° ° °

Mr. McFarland

Ernest C. Breeding of Houston, Tex., has been elected comptroller of The Texas Co., it was announced last week by **W. S. S. Rodgers,** chairman of the board. Mr. Breeding succeeds **Ira McFarland,** who retired Sept. 1 after he had served as comptroller for 31 years. **R. G. Rankin** will succeed Mr. Breeding as assistant comptroller.

Mr. Breeding was first employed by The Texas Co. in 1921 as an accountant. He was appointed assistant comptroller in 1939. He is a member of the Comptrollers Institute of America and the American Petroleum Institute.

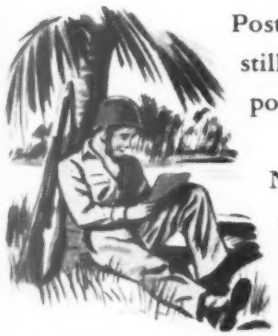
Mr. McFarland was the oldest Texaco employe in point of service when he retired. He started with the company as a stenographer in 1902, and was successively telegraph operator, bookkeeper and paymaster. In 1911 he became general auditor, and he was appointed comptroller in 1913.

"OLD FAITHFULS"

BOTH doing a fine job all over the country. Both good for the duration—and then some!

National Computer Pumps, like the famous "National Duplex" and the old reliable "National Simplex" of the late 20's, have a style and a reputation for service hard to beat.

Post-war Nationals will be still better. Include them in your post-war plans.



Write the Boys Regularly.
Buy Bonds Regularly.

Not only are National Pumps in service stations all over the country helping win the war, but our plant and all our facilities have long been devoted exclusively to war products.

We build parts for:

ANTI-AIRCRAFT GUNS
GUN MOUNTS
LAND TANKS
"WATER BUFFALO" TANKS
RADAR EQUIPMENT
PT-BOATS
P-38 STARTERS, ETC.

But after the war, with our increased facilities, we will again serve you with the finest gasoline pump equipment available.

NATIONAL PUMPS

NATIONAL PUMPS CORPORATION
GENERAL OFFICES: CINCINNATI 23, OHIO
FACTORY: DAYTON 1, OHIO
Pacific Coast Division:
79 New Montgomery St., San Francisco, Calif.

...and Not a Friend Kicked in the Teeth!

Judging from the advertisements, we seem to be one of the few factories that failed to win the War single-handed.

We did the best we could—*we increased our output of war materials 2000% over normal peacetime production, and we were voluntarily handing back our excess profits to the government before re-negotiation ever went into effect*—but, to be perfectly honest about it, we were so badly scared after Pearl Harbor that we would have promised to do twice as much with no profit at all if it would only help keep our country from going down in the shambles with the rest of the world. In other words: "When the Devil was sick, a Saint was he."

We did make one war-time record though, of which we're genuinely proud:

NOT ONCE DID WE EVER USE THE WAR AS AN EXCUSE TO DODGE A COMMERCIAL ORDER, AS AN EXCUSE FOR ROTTEN SERVICE, FOR SHODDY CONSTRUCTION, OR FOR ARROGANCE.

The Job We Did...

We *fulfilled every single commercial order* offered to us for which materials were legally available. We *tackled every single repair job* that anybody asked us to undertake. And, in spite of all the headaches involved, we managed to make pretty decent deliveries, and to keep the quality of workmanship up as high as was humanly possible to produce.

It sounds a little screwy for a Manufacturer to brag about doing the very thing a Manufacturer is supposed to do: Take better care of his Customers than any competitor possibly could. But it's not as easy as it sounds. In a war-order-gorged-plant it's a mighty temptation to use the war as an excuse to keep from "bothering" with a commercial order. The paper work alone involved in the appeals to Limitation orders, priorities, official correspondence, etc., is enough to make a factory want to duck the transaction. After the paper work has been ploughed through, the next job is to plead, threaten and curse to get in materials from our sources of supply. Then, all the Production Manager has to do is sweat blood to dig up enough man-power to get the work out some way *without interferring with War contracts.*

And handling *repair work* under War conditions is a very special headache that should be reserved only for the most stubborn cases in Purgatory. Yet, we have completed job after job of repair work on equipment which the operator had purchased from our competitors. Incidentally we have never increased even by a fraction of a percent the normal peacetime profit on repair work.

The Seller's Obligation...

Our philosophy about *taking care of commercial customers in War-time* has been simple: Color and flavor the story any way you will, the inescapable *fact remains that a Manufacturer lives off his Customers.* No customers; no factory—and Lord help the Manufacturer who forgets it. If you want customers when the going is tough, you'd better take care of those customers when *they* have troubles.

If ever a corporation had reason to be grateful to its customers, Standard Steel Works has. We might not have weathered the depression years had it not been for staunch Customer-Friends who stood by us. And grand Customer-Friends of more recent years helped us to win national recognition in our manufacturing fields.

So, to us, these war years have been a golden opportunity to repay *friends that we needed before the War—and that we are going to need more than ever after this War is over.* If we say it ourselves, no Manufacturer ever tried harder under more difficult circumstances to pay his obligations in full.

LIST OF PRODUCTS

TRUCK TANKS — TRAILER TRANSPORT TANKS

AIRPLANE REFUELERS — AIRPLANE REOILERS

Standard Steel Works

NORTH KANSAS CITY, MO., U.S.A.

TECHNOLOGY DEPT:

NATIONAL PETROLEUM NEWS

Monthly Technical Section Devoted to

REFINERY MANAGEMENT *and* PETROLEUM CHEMICAL TECHNOLOGY

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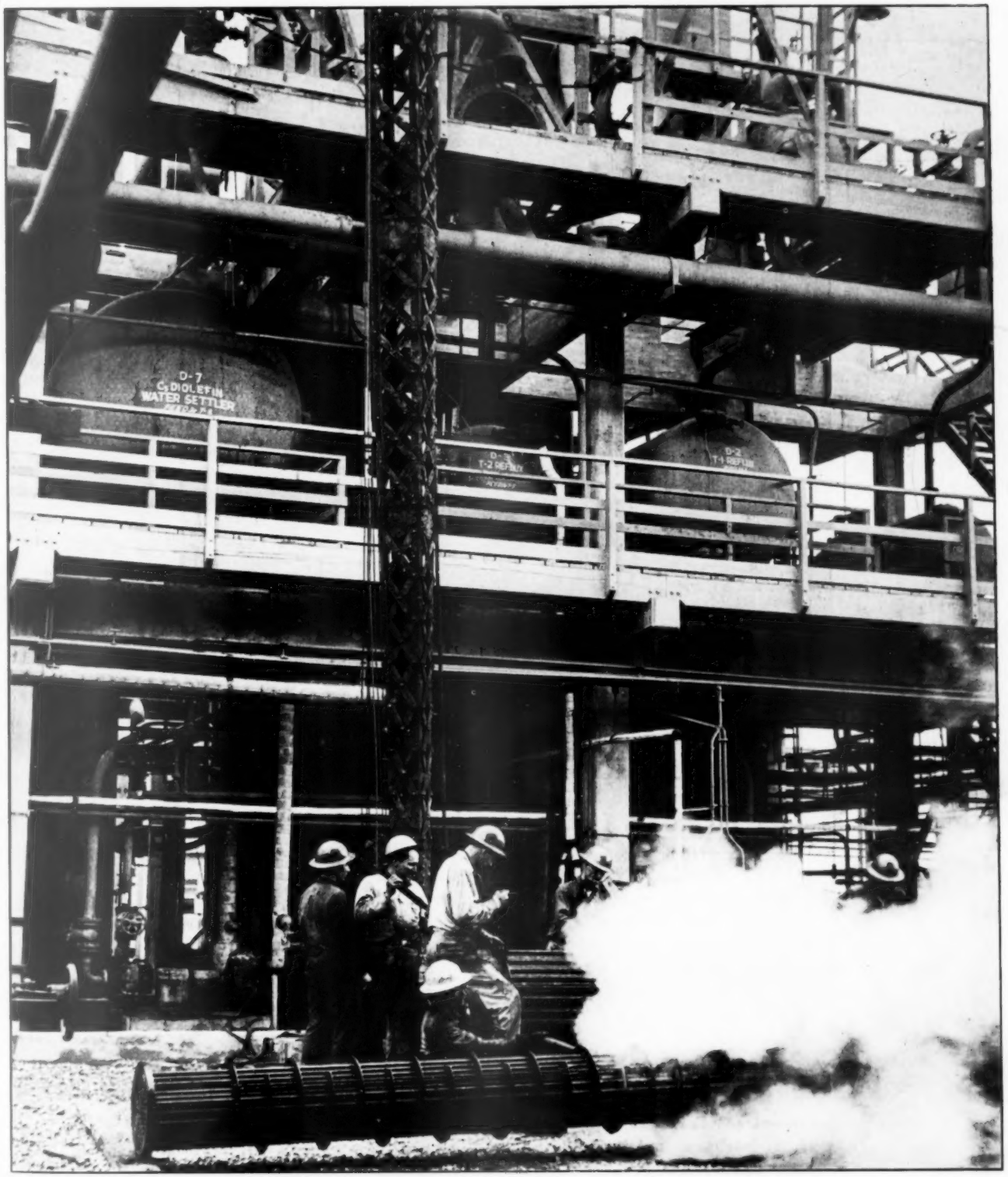
Section Two **September 6, 1944**



MAINTENANCE HOLDS HIGH WORK PRIORITY: The wartime shortage of many refinery materials and parts will last another six months, PAW authorities state. Plant operators are urged not to relax in their inspection and repair programs, to keep present equipment functioning while the military programs are at their peak. This photo shows the maintenance crew at the Bayway, N. J., refinery of Standard Oil Co. of New Jersey steaming out the tube bundle of a heat exchanger, in a regular checkup of a cracking unit

R. J. S. Pigott . . .

Will Direct Co-operative Research in Engine Oils

Joint research work of the petroleum and automotive industries in lubricants has been centered in the Coordinating Lubricants Research Committee of the Coordinating Research Council. This pattern of organization has been used effectively in co-operative fuel research as sponsored through the C.R.C. by the Society of Automotive Engineers for the automotive industry and the American Petroleum Institute for the petroleum industry. Representation of Army and Navy is also provided during the war in the various committees.

Chairman of the Engine Oil Division of the New Coordinating Lubricants Research Committee is R. J. S. Pigott, of Gulf Research & Development Co., Pittsburgh. Mr. Pigott has specialized in mechanical engineering developments since 1906 and since 1916 has been chairman of the special research committee on fluid meters of the American Society of Mechanical Engineers. As staff engineer for Gulf, he has charge of engineering research and joint experimental work on lubricants and fuels with the chemistry division of Gulf Research & Development Co. He has supervised design and layout of all laboratory buildings of the company.

REFINERY MANAGEMENT *and*
PETROLEUM CHEMICAL TECHNOLOGY

Sept. 6, 1944
Volume 36
Number 36

A MONTHLY TECHNICAL SECTION OF NATIONAL PETROLEUM NEWS *incorporating International Petroleum Technology*

Don't Let Up in Refinery Maintenance Programs, PAW Cautions Operators

WASHINGTON

THE OUTLOOK for critical materials and parts for refinery maintenance and repair has not improved as a corollary of the brighter military outlook, it is pointed out by directors of the Materials Division of the PAW. The necessity for the most careful allocation of certain materials continues, and some parts and completely fabricated equipment still remain bottlenecks, in spite of all efforts of manufacturers to relieve this situation.

Many materials and parts are likely to remain difficult to procure for another six months, these PAW officials state. They urge operators whose plants are now meeting the peak military demand not to relinquish in any respect their efforts to keep their plants running with the parts and equipment on hand.

Where it is known that replacement parts will be actually needed in the forthcoming months, refinery operators are asked by PAW to anticipate those needs and place orders as far ahead as possible. In general the plants are asked to keep up their present inspection and maintenance programs and even not to start on unnecessary maintenance work, regardless of the turn in the war news.

There has recently been much newspaper discussion on the plans of government agencies to allocate materials for the conversion of some of the wartime industries back to making peacetime goods as a bulwark against extensive unemployment in such industries when their production of war goods ceases. This, it is said, has given some people in the oil industry the idea that materials and equipment on the critical list are now easier to obtain. The PAW Materials Division directors advance three reasons why the materials situation continues critical for many items.

1—There has recently been an actual volume reduction in the production of some basic materials. While these materials may not be those used by refinery and gasoline plant operators, they are used by manufacturers of equipment supplied to the plants and thereby affect the supply of such equipment. One reason for the dropping off of production in these materials is that workmen, believing the end of the war is in sight, are leaving the war plants and looking for permanent jobs even at less pay.

2—The present military campaigns result in the expenditure of supplies of all kinds at a tremendous rate. Whereas a few months ago these supplies were stored in great quantities in England and at other bases they are now being used up and must be replenished.

3—The widely heralded program of the government to protect against unemployment in some of the war industries by allocating materials to them for their conversion to producing peacetime goods has given the public a false impression on the critical materials situation in general. If consideration can be given to allocating some of these materials to the production of peacetime commodities, the reasoning goes, it must be less difficult to secure maintenance and repair parts for such an essential industry as petroleum refining. Actually the reconversion program as contemplated would create another outlet for the present supply of materials.

The wartime supply of most raw materials is far short of the requirements of all claimants, say the PAW officials, and many cutbacks in amounts asked for are necessary. For the fourth quarter requirements the outlook in general is not considered good. "The manpower shortage will continue and there are some important military programs which will seriously affect the materials picture" states a current report from Claude P. Parsons, Director of Materials of the PAW. To show the stringency of the present situation these officials cite a case where a pump repair part weighing 1200 pounds was shipped by air from California to an East Coast refinery at a transportation cost of over $1500. This avoided shutting down the plant for the 10 days it would have required to transport the part by express. The transportation charge was high but it would have cost more to shut down the unit for 10 days.

In general, refiners are advised that five months is the least time in which deliveries can be expected of repair parts on pumps and pump packings on normal priorities and without special directives and upgrading of orders, such as the Materials Division can secure only in most urgent cases. Much the same situation is said to apply to valves and electrical equipment, including starting equipment, motors and motor parts, and control instruments. On control valves it is said that 16 - 20 weeks is the shortest time manufacturers can make deliveries on the usual priorities. On carbon steel plates and tubing it is said that deliveries cannot be guaranteed before February without special preference orders. The admiralty metal and copper situation remains critical.

The PAW has received from the WPB further recognition as a claimant agency for the petroleum industry which aids in its efforts to secure materials and supplies for the industry. It has now been delegated the authority to authorize projects up to $100,000 without submission to WPB. Previously the delegation was for amounts only up to $25,000. The fact that this and a few other relaxations have been secured by the Materials Division for the relief of the petroleum operator, however, places upon operators an additional obligation to justify requests for materials. "Any abuse of priorities, even by a minority, will certainly react to the disadvantage of the whole industry," states a PAW bulletin, "in which case we are likely not only to lose the privileges gained but the accompanying loss of prestige will make it extremely difficult to re-establish our former position.

"The fact that relaxations have been obtained should not be the basis for increased optimism over the immediate future of the materials picture. We will be able to obtain a suitable quantity of materials for the petroleum industry only by putting up a fight and by constant plugging. We must repeat that materials are still tight and that they will remain tight so long as there are major military uncertainties."

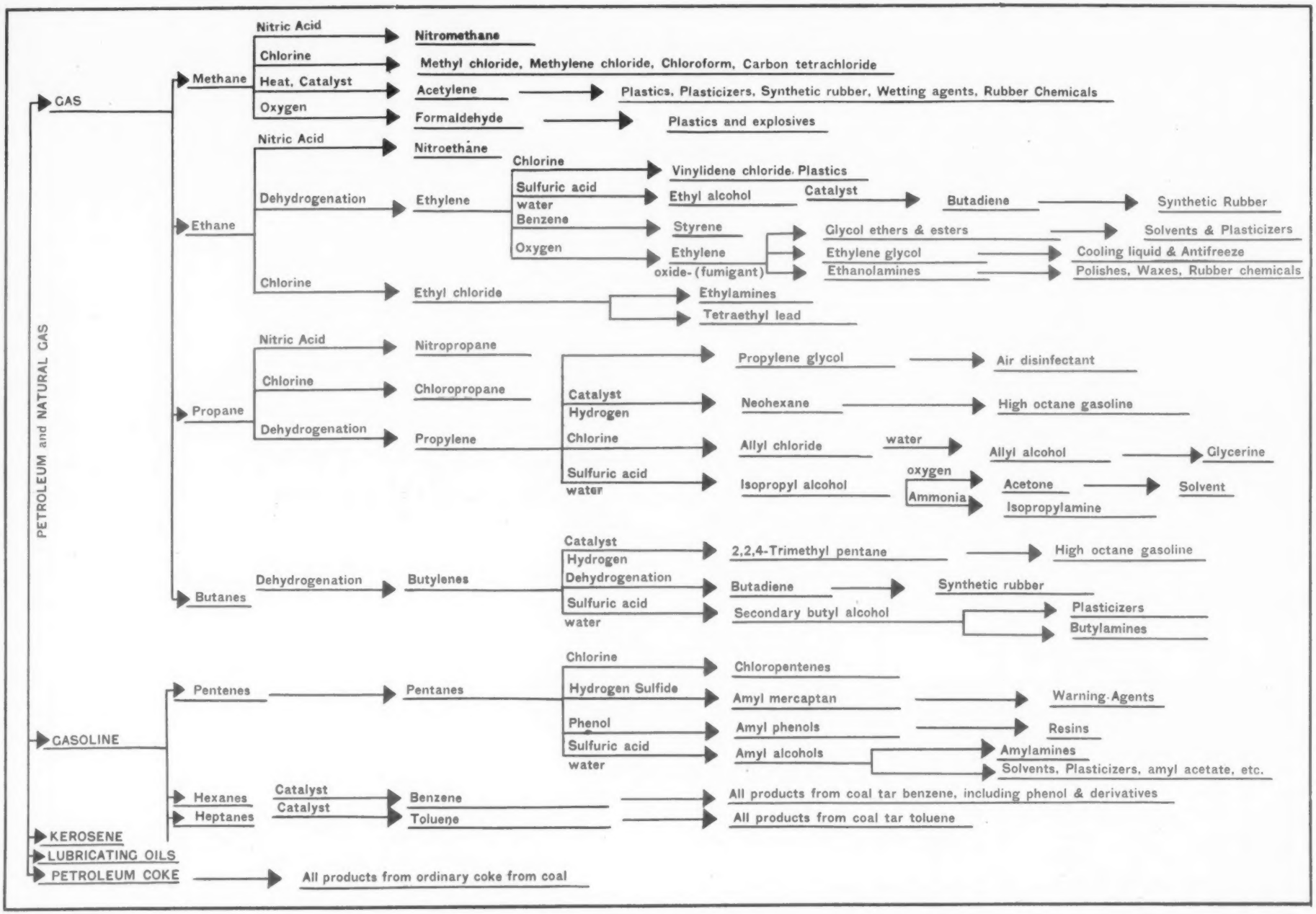


Fig. 1—Chemical Industry Derived from Petroleum and Natural Gas

"Of the various source materials for organic chemicals, it appears unlikely that there will ever be a better source than petroleum. The next 20 years in the chemical industry may well be spoken of as the 'Petroleum Era'."

This conclusion is reached by two prominent authorities after a study of the growth of the American chemical industry and its future outlook. Their survey was presented before an institute for industrial executives in the southwest.

These chemists believe the business of manufacturing organic chemicals will eventually be as large as the inorganic chemical business, which got its real start in the last war. The value of its products may reach $800,000,000 or more annually, they say.

Any check on the production by oil companies of the large volume products such as gasoline would not affect the Petrochemical industry, they state, since production of all the organic chemicals in the country from petroleum would not utilize one-tenth of the petroleum used for gasoline manufacture. Also natural gas will be used as a base for petrochemicals.

The accompanying article is the portion of the original survey which discusses the manufacture of chemicals from petroleum bases. The summary is also given in full. The original presentation also included considerable statistical data on the general chemical industry in this country. This is reviewed and some of the tables published (see pgs. R-572-3) to show the reader the extent, growth, markets, and earning capacity of the American chemical manufacturing business.

THE COMING PETROCHEMICAL INDUSTRY

Petroleum and Natural Gas Seen as Most Important Raw Materials for Manufacturing Organic Chemicals in the Coming Decade or Longer

By George E. P. Smith, Jr., and Henry F. Palmer

PETROLEUM and natural gas are just coming into their own as raw materials for chemicals. This trend towards the use of petroleum and natural gas for the synthesis of commercial organic chemicals is the outstanding recent chemical trend.

Starting with an extremely crude natural product, the petroleum industry was first built upon a simple fractional distillation of the crude oil, to which was later added a preliminary chemical separation by treatment with oleum (sulfur trioxide in sulfuric acid). During the last decade and especially in the last five years, the research laboratories of the petroleum industry have developed methods for reacting their raw materials and separating the products into relatively pure compounds. These compounds form the basis of a great deal of our fighting as well as of our future peacetime strength.

Whereas products from some other natural sources have proved difficult of expansion in the present emergency, the chemical utilization of petroleum and natural gas has opened the way to the tremendous production of basic organic chemicals, production considered absolutely impossible even a few years ago. Some of the products produced from petroleum are shown in Fig. 1.

Liquid fuel for power in airplanes and tanks now consists of a definite blend of relatively pure synthetic organic chemicals prepared from petroleum: 2,2,4-trimethylpentane, isopentane, and neohexane, together with small amounts of tetraethyl lead and ethylene dibromide. The production of this fuel has been expanded at a tremendous rate; one company in 1942 produced 60 times as much 100-octane fuel as in 1940 and more than the total consumption of this product in 1941.

The use of this fuel gives 50% more power in a properly designed motor than could be obtained from the best gasoline of 10 years ago. In Thunderbolts, Liberators, Spitfires, Flying Fortresses and General Shermans, this fuel is contributing no small part to winning the battles of the Atlantic and of the Pacific, for our enemies are known to rely chiefly on poorer grade fuels. Because of recent advances in this field, every automobile on the road today is already obsolete from the standpoint of motor design for maximum power output.

This article is a portion of a survey entitled "Some Aspects of the American Chemical Industry", presented July 28 before the Southwestern Chamber of Commerce Institute, Dallas, Texas.

The statistical data and discussion on the chemical industry in general, appearing on pages R-572-3, are from the same source.

Both authors are associated with the Firestone Tire and Rubber Co., Akron.

Although fuel is and probably will continue to be the main volume product of the petroleum industry, the production has reached large proportions and great value in our economy of such chemicals as formaldehyde and pentaerythritol from methane, of alcohol, ethylene oxide, ethyl chloride, the ethanolamines, glycol, styrene, and acrylonitrile from ethylene, of butadiene from alcohol and from butanes, of isopropyl alcohol, acetone, allyl alcohol, and glycerin from propylene, of butyl and amyl alcohols from butylene and amylenes, of chloro- and nitro derivatives as solvents such as methyl and ethyl chlorides, etc.

It has been found possible by using the correct conditions of temperature, pressure and catalysts to cyclicize the straight chain compounds of petroleum, particularly hexane and heptane, to form cyclic compounds, e.g. benzene and toluene, whose sole source formerly was by-product coal tar. This is fortunate, for the demands of the Army and Navy and our allies for toluene for T.N.T. have exceeded anything dreamed of 10 years ago. One plant alone now produces more toluene than the annual U. S. capacity for toluene production from coal tar in 1918.

The phenol and cresols derived naturally from coal tar would have been but a drop in the bucket compared to the demand for these chemicals for plastics (Bakelites, adhesives, nylons, germicides, etc.). However, the benzene from coal tar, supplemented by some from petroleum, has been converted by a new synthetic oxidation process, using oxygen of the air, to phenol in tremendous quantities. In 1943, the production of synthetic

(*Continued on p. R-574*)

Fig. 1—Chemical Industry Derived from Petroleum and Natural Gas

The Manufacture of Organic Chemicals Became Major Industry in World War I*

*** A review of statistical data on the history and growth of the American chemical industry in the survey, "Some Aspects of the American Chemical Industry", by George E. P. Smith, Jr., and Henry F. Palmer, presented before the Southwestern Chamber of Commerce Institute, Dallas, Texas, July 28, 1944.**

IN 1914, at the beginning of World War I, the American chemical industry was a relatively small, steady, but growing business in organic salts and acids, together with a very few organic or carbon-containing materials from coal tar.

The growing market for organic chemicals in American industry, especially dyes and pharmaceuticals, was supplied mostly from German sources. The intermediates or starting materials were rarely seen or known in this country. This was also true for many of the less common inorganic salts and chemicals.

The cutting of ties with the Central European powers in 1917 was nearly disastrous to our supplies of all categories of chemicals necessary to the prosecution of the war. In response to both government and private demand the chemical business blossomed literally over night into a major industry, especially in the inorganic and explosives divisions.

The chemical industry, then largely inorganic, went through a typical industrial growth during and after World War I, and appeared, before World War II, to be leveling off within a fairly definite range of total value of products of about $800,000,000 a year. It is assumed conservatively that it may come back to somewhere near this figure after the present war.

Just how far the organic chemicals group will go is impossible to predict at this time. However, it appears that the organic business will be at least as large, eventually, as the inorganic business, thus making the total chemical business in the U. S. about double what it was during the twenties, after it had already quadrupled in the 'teens.

(*Note:* The chemical industry in this study is defined as including those businesses which produce, through chemical reactions, individual chemicals for their own value. It is entirely separate from the chemical processing industries. Many industries utilize chemicals in the processing of goods into finished products and in many cases the processes are partly chemical in nature, and certain industries produce chemicals incidental to other operations. These are generally classified as chemical process industries.)

Products of the chemical industry in this restricted sense accounted for 2% of the total value of all manufactured goods in the U. S. in 1937 and 2.1% in 1939; whereas the chemical process industries accounted for 20-50% of the value of manufactured goods, depending on the scope included. Fig. 1, Growth of the Chemical Industry, is based on the above restricted definition of the chemical industry.

Financial characteristics of the chemical industry are analyzed from data contained in the annual reports of 38 corporations, as reported by the Securities and Exchange Commission in its "Survey of American Listed Corporations." These 38 companies produced 87.5% of the total value of chemical production given by the Manufacturing Chemists Assn. in 1939. They do not include any oil company which makes volume products such as gasoline, fuel oil, and so on. Table 1 gives a summary of data from financial statements of these 38 companies, which is discussed as follows in the survey.

"Net earnings have been uniformly high, as compared with most industries, and this has been reflected in the accumulation of a substantial surplus, payment of regular dividends and the reinvestment of large amounts in the industry, in the form of new plants for old products, and research and development of new processes and new products.

"Maintenance and Depreciation expenses are high for the chemical industry; but Cost of Sales, including cost of manufacture, is lower than for many industries, being about 51-54% of sales. This allows a favorable net profit all the way down the profit and loss statement. Net profit from operations, 18% in 1939, was one of the highest reported for any industry by the Securities and Exchange Commission, being equaled only by the non-ferrous metals (19.7%) and the rayon industry (18.5%).

TABLE 1—Financial Characteristics of the Chemical Industry

(*A summary of data from financial statements of 38 companies, not including fertilizers, as compiled by the Securities and Exchange Commission. No oil companies producing volume products such as gasoline included*).

	1939	1941
Net Sales (Vol. of Business)	1,047*	1,755
Net Profit from Operations	189	431
Net Profit after all charges	200	223
Total Dividends	160	172
Total Assets	1,946	2,372
Capital Stock	919	915
Surplus	678	793
Net Profit from Operations (% Sales)	18.0%	24.5%
Net Profit after all charges (% Sales)	19.1%	12.7%
Ratio: Current Assets and Current Liabilities	5.49	2.29

**Figures given are in thousands of dollars.*

"This is a net profit after deduction of cost of maintenance, depreciation, taxes other than income taxes, selling, general and administrative expenses; but before deduction of prior claims, interest expense and income taxes. It is the income taxes which, since 1941, really take the glitter out of any earnings report.

"The new organic chemicals business appears to be more profitable than the older business in inorganic chemicals. This should be expected because the newer organic chemicals are still being commercially prepared under patent protection for the most part; whereas the large-volume inorganic chemicals are in many cases being manufactured under processes which are patent-free but under conditions where the large volume production by one (or a few) companies is the most economical."

A breakdown of the chemical industry's sales dollar is shown in Table 2 and is commented upon in Smith-Palmer survey as follows:

"Labor costs in chemical production are generally low. In 1937 labor costs were estimated at 12% of the value of all chemical products. Chemical reactions are controlled by materials, instruments and technical skill more than by human hands. For this reason, the wages tend to be unusually high, since chemical operators must be fairly intelligent and must be especially trained, usually over a period of months or years.

"Included in the costs of production of the chemical industry is one very important item, upon which the industry as a whole has based a great deal of its expansion; that is, research. In 1937 and 1938, the chemical industry employed over 300 re-

search workers per 10,000 wage earners, or about a fifth of all the research workers in the country.

"The expense of chemical research in 1938 amounted to 3.3% of sales (22 companies) or more than 18% of net profits from operations. The organic chemical industry reports a higher figure, 4.3% of sales for research in the same year 1938, and the

TABLE 2—What Becomes of the Chemical Sales Dollar

(*Data from 38 Companies as Compiled by Securities and Exchange Commission. No oil companies making volume products included*).

Factory Costs of Production°	1939	1940
Raw Materials		
Wages and Sales Supervision, etc.	$0.542	$0.526
Selling		
General and Administrative Expense	0.135	0.122
Maintenance and Repair	0.044	0.044
Depreciation and Depletion	0.062	0.057
Miscellaneous		0.032
Taxes	0.060	0.107
Net Return from Operations	0.157	0.112
	1.000	1.000
Net Return from other Income	.034	.055
	1.034	1.055

°*Important item in costs of production is research. Expense of chemical research in* 1938 *ranged from* 3.3% *to* 4.3% *of sales. American industry as a whole spent about* 0.2% *of sales for research in* 1938.

figure was 5.0% in 1933, when sales were smaller. American industry as a whole is estimated to have spent about 0.2% of sales for research in the same year, 1938.

"This emphasis on research is important in the history of the industry. It has meant expansion into new products and markets, rather than the simple expansion of the production of one or a few items. Thus, each of the large chemical companies has diversified into many new fields, while at the same time opening the road to the development of still other new chemical products.

"Another corollary of this method of expansion is the time, effort and expense which is necessary for the commercial development of most chemical processes. Experience has shown that usually a long, expensive period of research and semi-commercial production is necessary to perfect a process. Six years from discovery to the first commercial shipment is often quoted as an average in the industry, but many processes have taken longer than that.

"However, once a use and process are established, the experience has been that usually the business is fairly stable. It is well that this is so, for chemical plant equipment is expensive. In 1937, plant investment was estimated at $11,250 per wage earner, a figure which combines two factors; high cost of equipment and a relatively small but highly trained labor force."

The majority of chemicals are used in the processing of materials into finished products. The trend in consumption by some of these chemical process industries is shown in Table 3. The figures reflect both the growth of the industries and the increased use of chemicals in processing operations. If the percentage increases, 1935-1941, as shown in the table, are rearranged in the order of magnitudes, it is seen that the plastics industry tops the list as the fastest growing user of chemicals. On this point the survey states:

"The textile field has also become related to the plastics industry and to the chemical industry, since the synthetic materials which are spun into fibers are generally plastics and can be used in other forms than fibers. In addition, synthetic chemical detergents, wetting agents, coatings, and treatments such as mothproofing, waterproofing, crease resisting, etc. for fabrics, have increased tremendously in recent years.

"The rubber industry itself may step right into one of the first places in this table, if the various synthetic rubbers now in production hold their markets. The government has invested

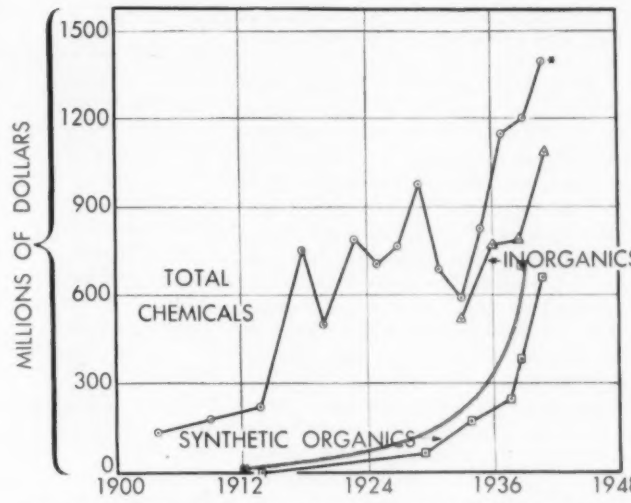


Fig. 1—Growth of the American Chemical Industry. Curve connecting each point shows considerable irregularity, indicates all was not always smooth sailing. Smoothed-out curve (in red), however, shows a fairly definite trend. Data were taken from "Chemical Facts and Figures" of the Manufacturing Chemists Assn. The chemical industry is defined to include operations producing, through chemical reactions, individual chemicals for their own value, not industries utilizing chemicals in processing goods into finished products

° *From Chem and Met Eng, Vol.* 49, *Feb.* 1942.

approximately $700,000,000 in plants and equipment for the production of synthetic rubbers and of the chemicals from which it is produced. This is equal to approximately 70% of the total private investment in the chemical industry up to the time of the war. The industry so produced and now operating is typically a chemical industry, produced in the emergency at a faster rate than any chemical industry ever was before. That it could be done at all is a tribute to the industrial chemists and chemical engineers of this country. The future of this business will depend on the quality and price of the products in the post-war period.

"At the other end of the list are the leather, glass, petroleum, paint and varnish, industrial explosives, and fertilizer industries. It should not be inferred that these might not become profitable chemical outlets. The opposite is true and the development of some new outlet or use for chemicals in these fields offers great possibilities. The very fact that leather is at the bottom of the list might indicate a profitable field in which to look for increases in chemical consumption. Fertilizers constitute the largest bulk business in chemicals, and the discovery of a marked improvement in a fertilizer composition, for instance an inexpensive plant growth stimulant, could result in a very large new business."

TABLE 3—Consumption of Chemicals by Industries

Industry	1935 Base Year	1941	Per cent Growth 1939-1941	Growth Position
1. Fertilizer	19.47	31.49	61.8%	7.
2. Pulp and Paper	12.39	21.92	77.0	6
3. Glass	10.58	15.03	42.1	12
4. Petroleum	10.51	15.20	44.7	11
5. Paint, Varnish, Lacquer	10.35	15.03	45.2	10
6. Iron and Steel	7.20	12.88	78.8	5
7. Rayon	6.29	12.87	104.5	2
8. Textiles	6.11	11.06	97.3	3
9. Coal Products	5.74	9.28	61.7	8
10. Leather	3.95	4.88	23.5	13
11. Explosive (Industrial)	3.62	5.54	53.0	9
12. Rubber	2.17	3.91	80.2	4
13. Plastics	1.62	3.71	129.0	1
	100.00	162.80	62.8%	

Chem. Met. Eng. 49, 80 (1942); 50, 124 (1943)

(*Continued from p. R-571*)
phenol was estimated to have been more than 20% over the *combined* synthetic plus natural production for 1942. This has been supplemented also by considerable synthetic phenolic compounds produced by new processes directly from petroleum, and the picture of the joint use of products from coal tar and petroleum may be typical of the future.

An example of an industry which has grown up and of the organic chemicals prepared from both coal tar and petroleum is the plastics industry. As a direct result of the necessitous demands for the production of war products, the plastics industry has emerged from an industry of many small uses to one of some very large uses: production has grown almost over night from statistics in pounds to statistics in tons.

Among the large scale uses may be listed the use of certain types of phenol-formaldehyde and of urea-formaldehyde resins as adhesives in the production of plywood. This has proven to be very useful in the production of light airplanes, such as Britain's Mosquito Bomber, but in peacetime it will probably be useful for the production of boats, furniture, housing units, and a thousand and one other uses besides the production of airplanes. Between 1942 and 1943 the production of phenolic resins was expected to be doubled as a result of the tremendous increase in synthetic phenol manufacture.

Nylon is aso based on phenol as an intermediate, and is now used in the production of parachutes, and of strong but light ropes and tackle of all kinds. Nylon can be used as a molded plastic, also, and increased use is expected along these lines after the war. The production of nylon is probably equal to the originally projected 20 million pounds per year.

The vinyl resins derived from calcium carbide and acetylene have expanded tremendously in all sorts of uses. Production of the vinyl chloride-vinyl acetate copolymers has approached a production of 50 million pounds a year. Besides these, other vinyl resins produced on a large scale are polyvinyl alcohol and polyvinyl butyral. Production of these has doubled since 1941 and then doubled again. The butyral is now the leading material for the center of the "sandwich" in safety glass, and also as a replacement for rubber in the heels and soles of shoes. All the vinyls are used as fabric coating materials and many are used as substitutes for rubber in a variety of uses.

Polyvinylidene chloride is a relatively new, promising plastic derived from ethylene and chlorine. It produces a very strong and weather resistant fiber for use in screens, tents for the tropics, or upholstery, furniture, etc.

The polymethylmethacrylate resins, derived from acetone from propylene, are the Plexiglas and Lucite of commerce. They are being produced in large amounts for airplane windows, bomber noses, and goggles. They are crystal clear and do not shatter but suffer from the disadvantage of being somewhat softer than glass, hence are more readily scratched.

Cellulose, derived from cotton and wood pulp, is a raw material for a great deal of plastics production. Viscose is made by dissolving pure cellulose in sodium hydroxide and carbon disulfide. When forced through an opening into a dilute solution of sulfuric acid, the original cellulose is reformed in the shape of the opening. This is the basis for the production of all viscose rayon and cellophane.

Rayon is the largest volume plastic made; in 1942 the amounts produced were 480 million pounds of filament yarn, and 150 million pounds of staple yarn. Tremendous advances have been made in recent years in improving the tensile and flexing life of rayon, so that it and nylon are qualitatively better than cotton where strength with lightness or strength with high flexing life are demanded. Rayon has been made also into special products, such as crimped fibers having many of the same physical properties as wool, and an air bubble-filled product which is a satisfactory synthetic cork or kapok.

Cellulose acetate is used chiefly as a molding powder, in the form of heavy film for packaging, and for photographic film. However, in the form of fibers, it is made into the so-called "acetate silk" or "acetate rayon" which was widely used by the ladies before the war, and probably will be again after the war. In addition, a new fiber has been obtained, essentially by hydrolyzing off the acetate in the cellulose acetate fiber, thus forming a fiber of the original cellulose, but in different form; namely, a regenerated cellulose. This is called "Fortisan."

Ethyl cellulose is made by reacting cellulose with sodium hydroxide and ethyl chloride from ethylene, and has found use in flexible lacquer coatings for cables, for fabric coating, films, and as a rubber substitute for some purposes.

The use of cellulose from cotton or wood pulp is a typical example of the use of farm products, crops and forests, as raw materials for the production of chemicals. This possibility of the use of farm materials for chemical raw products has excited some chemists and economists, including Henry Ford, for a number of years. The proponents of this development have given the subject a name, "chemurgy," meaning "putting chemistry to work for the farmer." There is a National Farm Chemurgic Council which publishes a semi-monthly journal and holds an annual conference.

The field has received considerable impetus recently from the establishment of four Regional Research Laboratories of the U. S. Department of Agriculture. These laboratories in the last few years have developed methyl acrylate resins from lactic acid, butadiene from corn, natural rubber from numerous shrubs, and a rubber substitute, Norepol, from soybean oil and glycol. The synthetic wool fibers made from plant and animal proteins (casein, soybean, and corn) have not proven competitive as yet, but if certain improvements could be made, a wide field of use and perhaps a new industry would be opened up.

The fermentation industry is probably the world's oldest chemical industry, and it is still going strong. Recently it has been converted in this country from the production of whiskey to the production of industrial alcohols. However, although some progress has been made in adding synthetic flavors to dilute ethyl alcohol, the organic impurities which constitute the flavoring materials in the natural product have never been synthesized. (This might be a splendid problem for further extensive research). After the emergency it may be expected that the fermentation industry will swing back to whiskey production, partly because of the demand, but also because industrial alcohol from ethylene is a cheaper process than the fermentation of grain. Alcohol from ethylene can successfully compete with alcohol from cheap byproduct molasses.

Other chemurgical industries are those built on edible fats from vegetable oils,

Table 1—Typical Operations and Processes Used in the General Manufacture of Chemicals

UNIT OPERATIONS (PHYSICAL)

1. Storage	6. Evaporation (drying)	10. Crystallization	14. Mixing
2. Dewatering	7. Heat Transfer	11. Extraction	15. Crushing and Grinding
3. Evaporation	8. Fluid Flow	12. Filtration	16. Mechanical Separation
4. Levigation	9. Distillation	13. Absorption and Desorption	
5. Sedimentation			

UNIT PROCESSES (CHEMICAL)

1. Oxidation	7. Hydrogenolysis	13. Friedel-Crafts Reactions	18. Cracking or Pyrolysis
2. Halogenation	8. Amination	14. Hydration	19. Resinification
3. Nitration	9. Reduction	15. Esterification	20. Isomerization
4. Sulfonation	10. Acetylation	16. Alkylation	21. Cyclization (Aromatization)
5. Dehydrogenation	11. Diazotization	17. Polymerization	
6. Hydrogenation	12. Hydrolysis		

Many of the operations listed will be recognized as now being used by oil companies, particularly the chemical processes in modern refining operations.

and the production of soap and glycerin, a process which has not changed much in 150 years except for the addition of hydrogen to cottonseed oil to give an edible cooking fat, and the withdrawal of the elements of water from a molecule of castor oil to give synthetic drying oils for the replacement of tung and linseed oil in paints and varnishes. Other products from vegetable oils have found their way into many uses, including the manufacture of synthetic rubber and the production of plasticizers, i.e.: dibutyl sebacate from castor oil.

Many products have been developed recently from rosin and turpentine derived from the pine forests in the South. The development of a chemical process for making satisfactory pulp from Southern pines has made this industry a typical chemurgical operation. It should be regulated so that the relatively quick-growing pines continue to come to maturity at the same rate that mature trees are utilized. This process should slow down the rapid consumption of our own and Canada's spruce forests for paper pulp.

The chemurgical industries, however, ordinarily require expensive human labor to grow crops, to plant, tap and take care of trees, even to lumber them. Where the same material can be produced from petroleum or natural gas or other available natural resources, as well as from farm or forest products, the material from petroleum or natural gas or coal tar has usually proven in the end to be more economical.

Examples will occur immediately to everyone: the blue dye, indigo and other synthetic dyes from aniline; ethyl alcohol from ethylene; butadiene from either butylene or alcohol (from ethylene), nylon from coal tar and petroleum raw materials. Even soap is meeting increased competition from synthetic detergents, and Germany is supplying itself with synthetic soap and edible fats derived to a certain extent from coal. Where the products of chemical operations have come into competition with natural products the synthetic chemicals have enjoyed the following advantages:

1. A constant quality which tends to improve.
2. A stable price which tends to decline.
3. Unique chemical and physical properties not available in natural products.

Although usually higher priced to start with, the synthetic materials in nearly every instance have won acceptance and, as quantity production increased, costs have been lowered until the natural product could be undersold even under the most favorable circumstances.

We may be in the process of proving this very point in the case of synthetic vs. natural rubber—but much more rapidly on account of the war than would otherwise be the case. The only factor which seems to keep natural rubber in the picture is that of extremely cheap labor in the Far East. With the industrialization and general advance in standards of living expected in that area after the war, this kind of labor may be expected to gradually disappear. Natural rubber will be produced, but more efficiently, at a higher cost, and the expected trend will be to use it closer to the producing area; perhaps by people suffering from a lack of petroleum. The Japanese have been reported already to be producing aviation gasoline from natural rubber, whereas we have created an industry essentially upon the reverse chemical reactions.

The supplies of petroleum and natural gas are not unlimited, and there is thereby an implied warning to control production for the most economical usage. Petroleum and natural gas production are technically easy to control, and they probably will be subject to controls in the future.

The picture for the production of chemicals, especially of organic chemicals from coal and petroleum, is very bright, indeed. Any check on the production of gasoline would probably not affect the "Petrochemical" industry, as it has been called, since production of all the organic chemicals in the country from petroleum would not utilize one-tenth of the petroleum used for gasoline manufacture. With petroleum as a new source of raw materials in a typical American development, the chemical industry in this country should be able to keep its profit margins intact, lower costs, increase production, and undersell the entire rest of the world in organic chemicals. If petroleum supplies give out, coal may be converted to typical petroleum products by processes already commercially in operation.

We have discussed at some length the many products made from a comparatively few raw materials, mentioning chiefly the chemistry or process of change which occurs. The actual application of process of chemical change through a production basis occupies the attention of the chemical engineer. His importance to the chemical industry cannot be overemphasized, as the problems which he solves make possible the actual production of chemical products which are discovered by the research chemist.

The means by which these chemical processes are carried out have been developed to a high state of perfection and fall into two general classes, namely: unit operations and unit processes. The unit operations refer to the physical aspects of the process, whereas the unit processes are concerned mainly with the chemical changes. Table 1 lists some of these typical operations and processes.

Summary

1. The chemical industry is like a series of inverted cones resting on their apices, all of them with altitudes stretching upwards to infinity. The points of rest or apices are the raw materials, which are strikingly few in number: mineral ores, salts from brines, sulfur, the components of the atmosphere, coal, petroleum, natural gas, and products from growing plants.

Starting with a raw product, a chemical manufacturer can make by chemical transformations several primary products, from these, by further chemical reactions,

(*Continued on p. 647*)

Dr. Palmer

The Authors

Both authors of the original survey from which this article has been taken, "Some Aspects of the American Chemical Industry," are connected with the Firestone Tire and Rubber Co., Akron.

Dr. Henry F. Palmer (left) is manager of the company's Chemical Division. He started with Firestone in 1925 as a research chemist, and the following year was made chief chemist of Xylos Rubber Co., a Firestone subsidiary. In 1942 he returned to the parent company as assistant chief chemist. That same year he was loaned to the Rubber Reserve Co. in Washington as production manager, synthetic rubber plants, and remained with R.R.C. until this year, when he returned to Firestone.

Before coming with Firestone, Dr. Palmer was an instructor in chemistry at Dartmouth College, where he received his A.B. degree in 1921. He also holds M.S., Ph.D. and Ch.E. degrees from Ohio State University.

Dr. George E. P. Smith, Jr., co-author of the survey with Dr. Palmer, is head of research in organic chemicals for Firestone. He started with the company in 1935 as research chemist, being promoted to his present position in 1943. Dr. Smith was graduated from the U. of Arizona in 1926 with a B.S. degree, and later received his Ph.D. from Leland Stanford, Jr. University in 1930.

Deeper Cracking Triples Butylene Yield from Naphtha Reformer

Unit Operated at Severe Temperatures Since July, 1943, to Increase Output of Material for Aviation Gasoline; Equipment Shows no Excessive Wear or Corrosion

TO INCREASE production of olefins for codimer feed, Standard Oil Co. (Ohio) has been successfully operating a naphtha reforming unit at severe temperatures for nearly two years now—with only a slight increase in tube failures due to overheating, and even a general decrease in corrosion rates.

Yields of butylenes, using 60° API wide-cut naphtha as feed stock, have been found to be 194% greater at severe reforming (1150° F.) than at mild reforming (1070° F.), and are accompanied by a 46.6% increase in CFR-R octane number.

Standard's decision to go to higher operating temperatures and deeper cracking was made back in December of 1942. At that time they were beginning to produce codimer and were hampered by low butylene yields from their thermal crackers. They were also faced with a rising naphtha inventory.

To meet these problems, a 750-lb two-circuit tube-and-tank unit was revamped to crack wide cut naphtha in a once-through coil-only operation. This equipment originally installed in 1927 and known as No. 1 unit, operated on gas oil in the liquid phase coils and heavy naphtha stocks in the vapor phase coils before it was changed to high temperature operation.

Major change in converting it consisted of modifying the flow through the furnace. As shown in Fig. 1 the two furnace convection sections of tubing were put in parallel, followed by the lower radiant section, the outlet of which was tied to the inlet of the upper radiant section. These upper tubes are shielded by the lower radiant tubes and serve as a soaking coil. This arrangement provides a steep heating curve that flattens out markedly in the soaking section. The entire furnace contains 202 tubes, each 4½ in. O.D. and 25 ft. long.

The present flow through the naphtha reforming unit is shown in Fig. 2, with data on the equipment presented in Table 1. Originally the flow included three fractionating towers, but the first of these was by-passed after several runs since it was found unnecessary with the absence of any cycle stock on once-through reforming.

When the reforming unit was first started up in December of 1942, the soaker coil outlet temperature was held to 1080° F. Over a period of time, however, the severity of the reforming has been gradually increased as operating techniques improved with experience, and the unit has been operating at soaker coil outlet temperatures of between 1120 and 1150° F. since July, 1943. A summary of the development of these severe operating conditions is given in Table 2.

A record of the quantity and quality

TABLE 1—Data on Equipment in Naphtha Reforming Plant

TOWERS AND DRUMS

	Diam. (ft.)	Lgth. or Ht. (ft.)	Shell (in.)	Trays	Des. Press. (psi.)	Temp. (°F.)
Separator (2) (Horiz.)	8	30	17/32	..	70	750
Secondary Tower	9	40	22/32	10	70	750
Third Tower	7	40	22/32	14	125	500
Accumulator (Horiz.)	8	30	26/32	..	70	750
Light Dist. Drum	6	8	15/32	..	70	500
Heavy Dist. Drum	2½	6	12/32	..	70	500

EXCHANGERS

	Type	Passes Sh.	Passes Tu.	No.	O.D. (in.)	Ga.	Lnth. (ft.)	Mat.	Tot. Area (ft.²)	Des. Press Sh. (psi.)	Des. Press Tu. (psi.)
Low Press. (2)	S & T	4	12	344	1	9	12	St.	1080	125	250
High Press. (3)	S & T	4	8	304	1	9	12	St.	927	125	1000
Light Worm	Sub. Sec.		1		1	14	24		3600		150
Heavy Worm	Worm		1		4½				3776		
Tar Cooler	Worm		1		4½				1974		

TABLE 2—History of Development of Severe Operating Conditions

Run No.*	1	2	3	4	5	6	7
Coil Outlet Temperature, °F.	1080	1100	1120	1125	1130	1140	1150
Coil Outlet Pressure, psig.	230	160	160	160	170	190	240
Feed Rate, G/H	5700	5500	5800	5800	6000	6600	5700
Feed Gravity, °API.	55	59	59	59	61	61	60
Quench Rate, G/H	2500	2500	4700	4500	5500	6800	7500
Quench Gravity, °API.	35	48	48	48	48	30**	27
Separator Top Temperature, °F.	620	530	530	565	545	470	450

* These runs are in chronological order, although not necessarily consecutive.
** Changed from Heavy Distillate to Tar for quench stock.

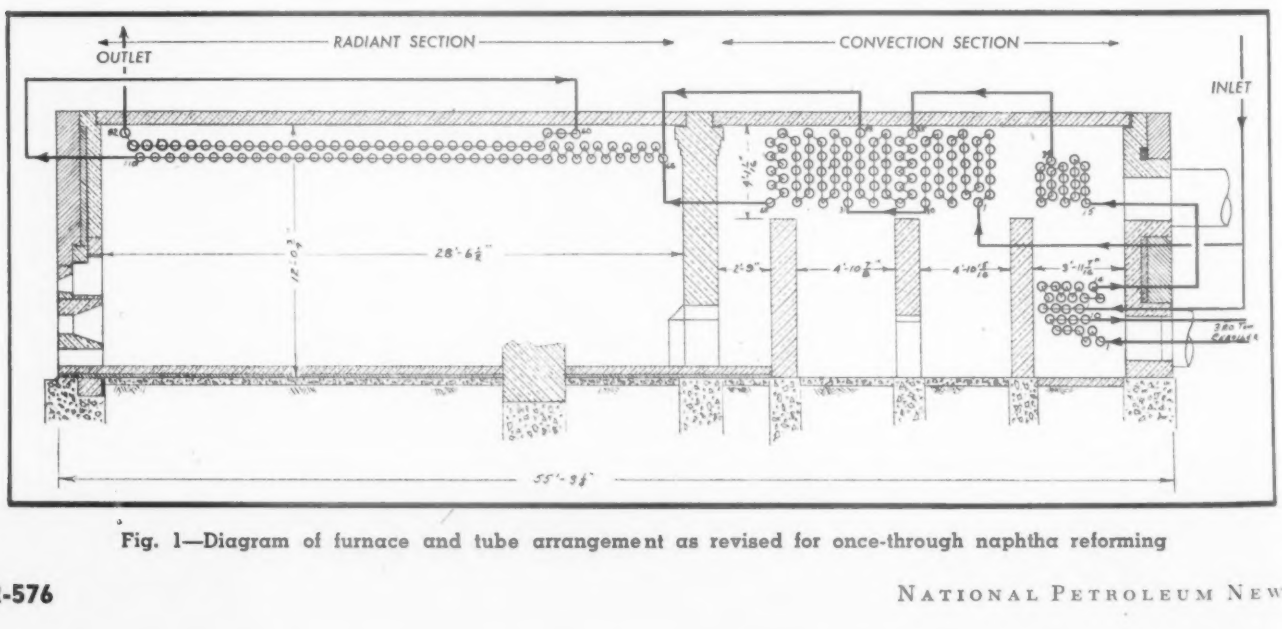


Fig. 1—Diagram of furnace and tube arrangement as revised for once-through naphtha reforming

of yields from each run through the naphtha reforming unit is not available, since the distillate and gas product streams from all units at Standard's No. 1 Refinery go into a common plant for debutanizing and gas recovery. A series of three tests have been run on the reforming unit at different temperatures, however, in order to determine its production at various intensity levels.

From Table 3 it can be seen that the butylene production is increased from 93 BPSD to 275 BPSD, an increase of 194%, by raising the coil outlet temperature from 1070° F. to 1150° F. and decreasing the feed rate 31%. And boosting the outlet temperature to 1200° F. results in even greater butylene production—345 BPSD, an increase of 271% over the mild reforming yield.

TABLE 3

(Test Conditions and Yields from Deeper Cracking of Crude Naphtha at Severe Temperatures)

Test No.	1	2	3
Feed Stock			
Gravity, °API	60.4	60.4	61.2
Mid. B.P., °F.	250	249	247
End Point, °F.	400	404	404
ASTM Octane No.	49.7	49.8	48.4
Rates			
Fresh Feed Charge, G/H	9014	6253	6132
Quench, G/H	3500	3000	6000
Furnace Firing, MM Btu/H	53.0	50.5	46.1
Temperatures			
Coil Inlet, °F.	285	261	256
Lower Radiant Inlet, °F.	614	668	780
Lower Radiant Outlet, °F.	998	1091	1113
Soaker Coil Outlet, °F.	1070	1150	1200
Pressures			
Coil Inlet, psi.	560	517	490
Radiant Outlet, psi.	440	444	380
Coil Outlet, psi.	175	195	193
Yields on Fresh Feed			
100% C_4 Gasoline			
Gasoline (100% C_4) vol. %	92.0	68.7	69.4
Gaso-free Tar, vol. %	1.8	2.3	2.0
Dry Gas, wt. %	6.9	29.6	31.3
Butane Yield			
Total Butylenes, vol. %	1.81	7.71	9.75
Total Butanes, vol. %	4.45	12.04	15.65
Butylene Production, BPD	93	275	345
Increase in B/D Butylene Production, vol. %		194	271
Product Quality			
Gasoline End Point, °F.	400	400	400
100% C_4 Gasoline			
RVP	6.82	16.38	21.08
CFR-R Octane No.	60.90	88.79	92.50
CFR-R Octane No. (+3cc TEL)	80.1	98.7	97.6
ASTM Octane No.	59.13	77.75	80.66
% @ 257°F. (D+L)	59.10	79.30	88.41

In terms of butylene yield per gal of feed stock, the increase is even greater—1.81% at 1070° F., 7.71% at 1150° F., and 9.75% at 1200° F.

Accompanying the higher yield of butylenes at these increased temperatures is a decreased yield of distillate. But the quality of the distillate is better. The CFR-R octane number of the clear 100% C_4 gasoline increases 46.6% for the

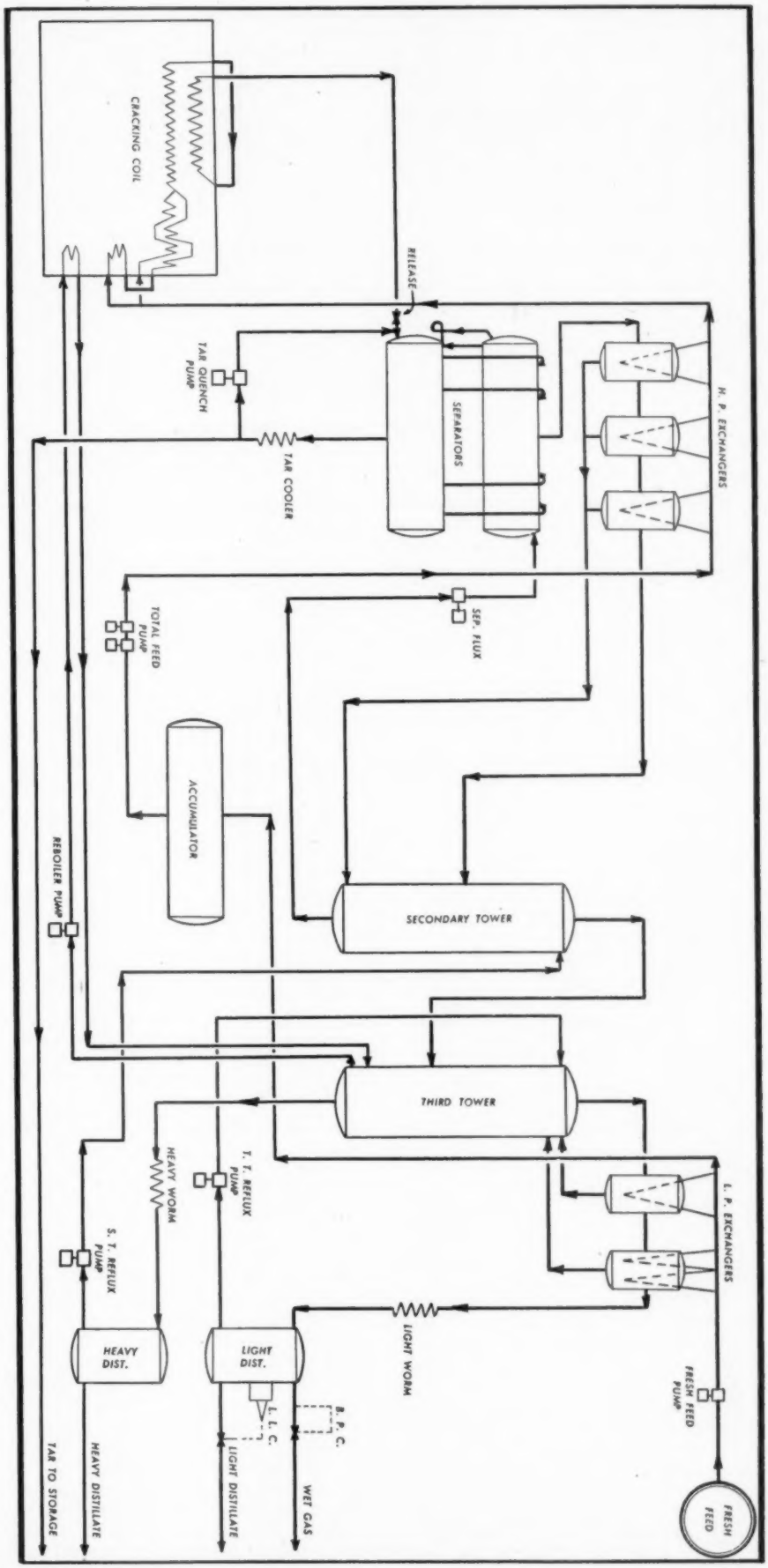


Fig. 2—Flow chart for naphtha reforming unit

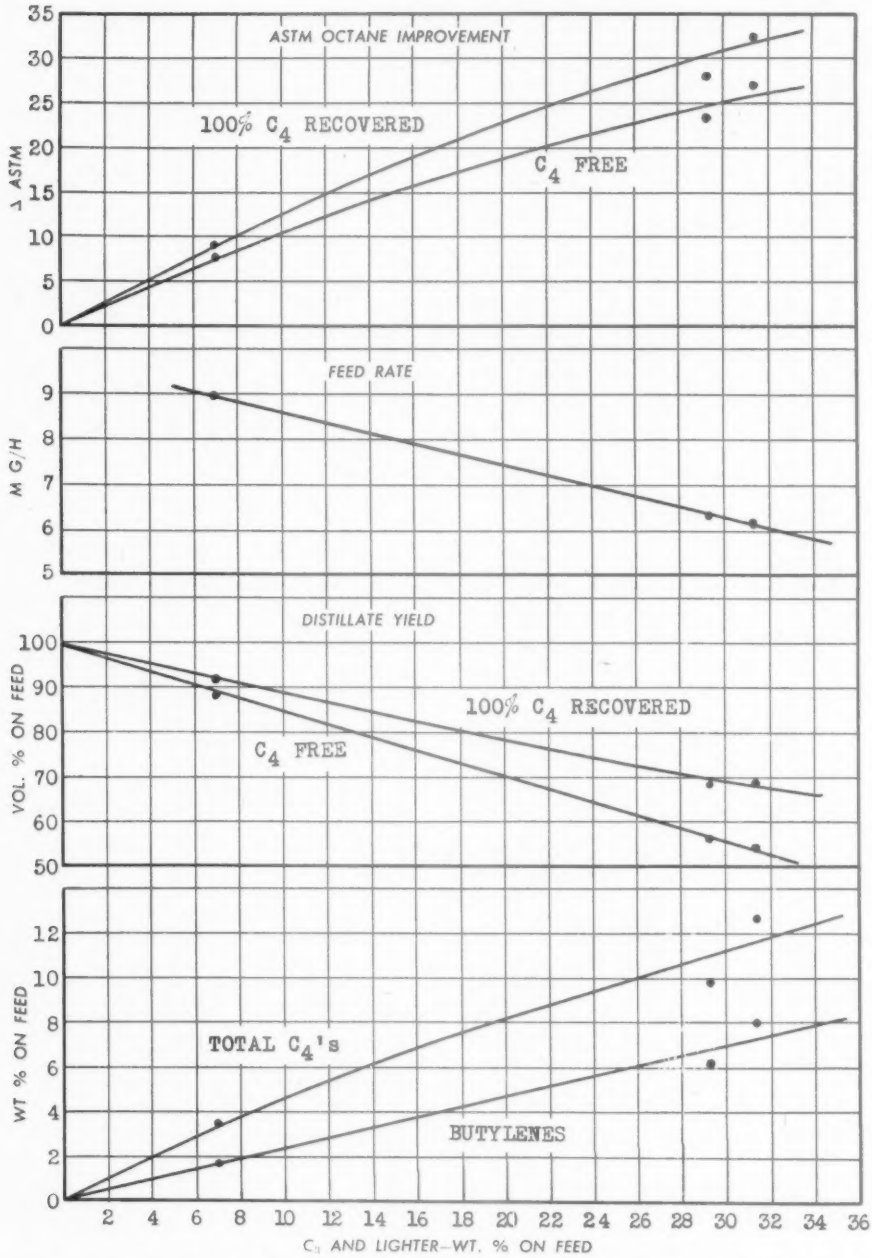


Fig. 3—Correlation of single-pass reforming of crude naphtha yields with dry gas (C_3 and lighter)

80° difference in outlet temperature, although its lead susceptibility drops 47%.

Results from these three tests have been correlated in the charts in Fig. 3, the yields of light hydrocarbons, distillate yields, feed rates and octane improvement all being plotted against the yields of dry gas (C_3 and lighter). It is possible through the use of these correlations to predict in advance the degree of reforming at any feed rate while maintaining the maximum firing rate of approximately 50 million Btu/Hr to the furnace. These correlations, of course, are based on results obtained for the charge stock being used by Standard—60° API, 50 ASTM octane number, and 250° F. MBP. However, the correlations should be sufficiently accurate to permit predicting yields from charge stocks that approach these specifications.

In connection with this correlation of the test results, all available data indicate that there is no definite correlation between the depth of reforming and the coil outlet temperature, and for this reason coil outlet temperatures were not included in the charts. Operating temperatures and pressures and contact times are all variables, each independently affecting the depth of cracking, and the yield of dry gas, the resultant of all these variables, is considered by Standard to be a better indication of cracking intensity.

The overall effect of these high temperatures has not been too hard on the equipment. A comparison of the condition of the equipment over a three-year period, including a year and a half before it was converted, shows that although there have been several failures of carbon steel header boxes in the radiant section and the rate of tube renewals has increased 13%, a general decrease in the corrosion rate on the tubes and fractionating equipment has been noted.

It should be pointed out here that all of the feed stocks used in this unit during this three-year period were obtained from crudes that averaged .25% sulfur in 1941, .36% sulfur in 1942, .42% sulfur in 1943 and .36% sulfur in the first half of 1944.

Fig. 4 shows the general trend in coil outlet temperatures over the period of comparison. Prior to the time that the unit was converted, the vapor phase coil outlet temperature was maintained at an average of about 1050° F., while the liquid phase was held at about 875° F. Since then, however, there has been a gradual increase in the coil outlet temperature, with the present trend being about 1150° F.

Tubes in the radiant section of the furnace have been mostly of 2% chromium steel during the three-year period. The rate of tube renewals in this section which can be attributed to overheating caused by the higher temperatures increased slightly, as shown in Fig. 5, while renewals from all causes since severe naphtha reforming operations were started, is up about 13%.

A large proportion of these renewals can be attributed to failure of the carbon steel header boxes. These boxes are of forged steel material in which a screwed and seal welded side plug is employed in the design to make forging possible. Due to fatiguing of the metal, cracks were found to have developed adjacent to these side outlet plugs. In one case the plug was even blown out of the box. It was concluded from this experience that carbon steel was not a satisfactory material for header boxes under the higher operating temperatures now being used, and future replacements will more than likely be made with 4-6% chromium steel.

To eliminate tube failures from overheating, replacements in the future will be made with 2% chromium steel tubing containing a slight amount of silicon in order to obtain better creep strength and oxidation resistance.

In general there has been a decided downward trend in the rate of corrosion of various tubes in the furnace and of pieces of fractionating equipment during the period of high temperature operation. There have been some cases of slightly increased corrosion, such as in the tubes in the former liquid phase radiant section of the furnace, and in accumulator. But these have been of only minor consequence. Even with the primary fractionating tower out of service, only a slight increase in corrosion rate was noted in the secondary and third towers.

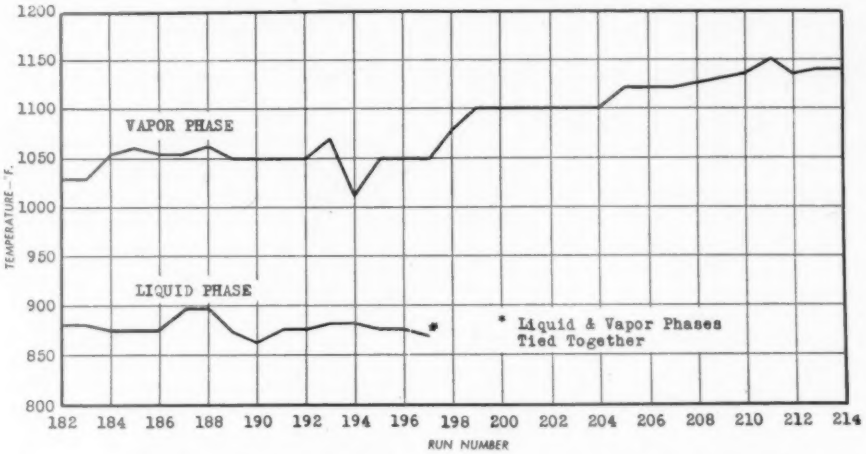


Fig. 4—Coil outlet temperatures before and after conversion to severe reforming operations

The corrosion rates for furnace tubes, towers, and vessels during the three-year period under comparison are shown in the charts in Fig. 6. Part of the decrease shown in the corrosion rate of the vapor phase radiant tubes might be attributed to the installation of alloy tubes in place of steel as renewals were necessary. Similarly, the decrease in corrosion rates noted for the two tar separators can probably be explained by the fact that a good portion of these vessels are lined with alloy.

The operating techniques used and improved by Standard's Refinery Process Department have enabled the development of the present severe operation, and there were a number of changes made in the equipment to overcome process problems as they developed from time to time.

One particularly troublesome problem was that of heavy coking in the release line and separators, which was finally solved by considerable study and experiment.

During the initial operation, quench stock was introduced into the coil outlet line (release line) at a point about 30 ft. ahead of the tar separators. Severe coking in the line following the quench point resulted. The quench inlet was then moved forward so that quench stock was introduced directly ahead of the separator inlet.

This change eliminated coking in the release line, but trouble was still being experienced in the separators. Quench stock used on the initial run was Secondary Tower Bottoms. Heavy Distillate

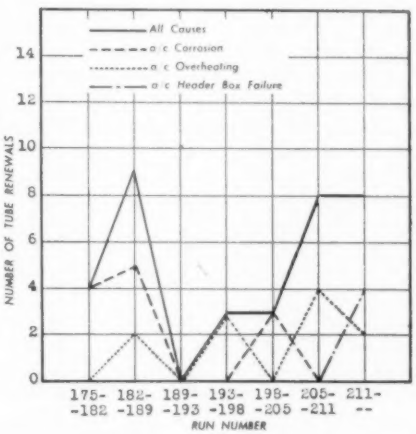


Fig. 5—Rate of tube renewals in vapor phase radiant section before and after conversion to severe reforming operations

was used thereafter, but without too much success in preventing coking, although some improvement was noted when the maximum possible amount of quench stock was employed. It was finally decided to use Tar for quench, and with the introduction of this stock the separator top temperature dropped to 450-480° F. and coking in the separators became negligible. The Tar quench provides a large volume of liquid which continually washes the surfaces of the separator, making it impossible for any of the tar to remain in the separator long enough to polymerize to coke.

It isn't known yet just how long the unit will operate without trouble from coking when Tar quench is used. No shutdowns have been necessary as yet because of coking, and some of the runs since the introduction of Tar quench have approached 2000 hours. According to Standard's engineering department, runs of from 2000-3000 hours do not seem improbable, in the light of recent experience.

Another factor which may have had something to do with the coking problem was the manner in which the quench rate was controlled. During the first seven months of operation on the naphtha reformer, the rate at which quench stock was fed into the release line was controlled by the separator top temperature. That temperature was upset whenever tar was pumped to product, which was an intermittent operation since the tar product was small (approximately 3% of feed). As a result of these fluctuations in the separator top temperature, the quench rate was not always constant—and may have had some effect on separator coking.

The line-up was then changed so that the quenching rate was held constant while the separator top temperature was controlled by the reflux to the top separator. This arrangement was partially successful in preventing pitch formation in the top separator, but was not completely satisfactory until the introduction of Tar quench eliminated excessive coke formation in the bottom separator.

Coke formation in the furnace tubes has always been slight on the once-through reforming operation; feed stock color is checked closely to prevent excessive coil coking. The problem of release line coking was solved, as previously pointed out, by moving the quench point so that quench stock was introduced just ahead of the separator inlet.

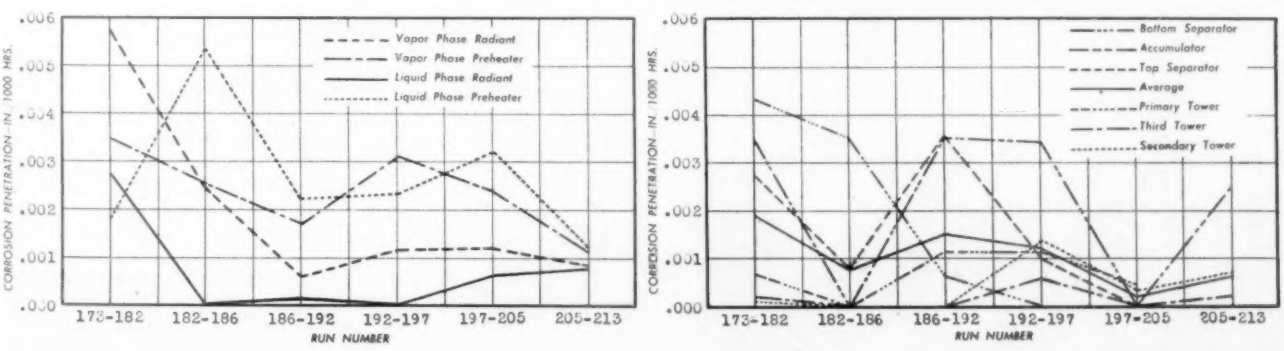


Fig. 6—Corrosion rates for furnace tubes, towers and vessels before and after conversion to severe reforming operations

Process Research in the Petroleum Industry

Development Work in Pilot Plants Continues to Increase In Importance as Refining Methods Become More Complex, Require Greater Control

*By S. H. McAllister**

With chemical and physical operations in refining processes becoming daily more involved, considerable research, study and planning are necessary before the commercial plant can be designed and built with confidence in its ultimate economical operation. To meet these needs, and also to keep their present equipment and methods from obsolescence, many refineries have set up research and development organizations.

This article, by a member of one such development company, details and explains the primary factors to be taken into consideration in the organization and operation of a process research division. Design of the pilot plant, its layout, construction and equipment, are also covered, together with personnel requirements.

PRIOR TO THE FIRST WORLD WAR there were relatively few industrial research laboratories in the United States, and we depended largely upon other countries and a few private and academic laboratories for our new technical developments. This situation changed rapidly during the period from 1918 to 1935, so that today research is a well established part of our industrial system.

It is indeed fortunate that this change took place, for it would otherwise have been impossible for us to have functioned as the "Arsenal of Democracy" and, while one should not minimize the excellent fundamental work now being done in our governmental and educational institutions, we must look to the industrial laboratories also for much of our immediate postwar planning. The economic frontier offered by such applied research is one of our more promising means of avoiding a sterile, regulated economy.

Developments in petroleum refining and its related chemical industry offer an outstanding example of the value of research. Processes in this industry, originally only rough physical separations of the naturally occurring components of petroleum oil into marketable products, have changed to a highly complex series of chemical and physical operations from which are derived new super fuels, lubricants, solvents, plastics, and a variety of other products. The reactions occurring are complicated and require careful technical control. And since the field of interest is constantly expanding or shifting in emphasis, a considerable amount of research work is required. Consequently, the larger petroleum companies have set up research and development departments or separate development companies to explore the field and insure their operations against obsolescence. While serving the commercial interest of the parent company, these research organizations also serve the public by producing improved products and entirely new materials.

Separate Management Desirable

The management of the research organization is usually separate and relatively independent from that directly responsible for manufacturing operations, as it is felt that the long range development program has a better chance for thriving if not interfered with by production urgencies. Furthermore, development work requires a somewhat different approach and a different type of personnel. However, this does not mean that research should be isolated in "an ivory tower", for over a period of time it must justify its existence to the operating company which supports it. In a certain measure this is also true of the public research institutions, but responsibility to the "stockholders" is less clearly defined in this case.

While the industrial laboratories have attracted many of our highest grade scientists, individual initiative and inspiration alone are not sufficient to guarantee ther success. It is important that a proper internal organization be provided to take full advantage of their skill, as it is often a long and devious path from the successful "test tube" experiment to the operating commercial plant, and the success of any venture may well depend more upon subsequent steps than upon the original "flash of genius". This fact is seldom appreciated by the public and is often overlooked by the laboratory scientist himself.

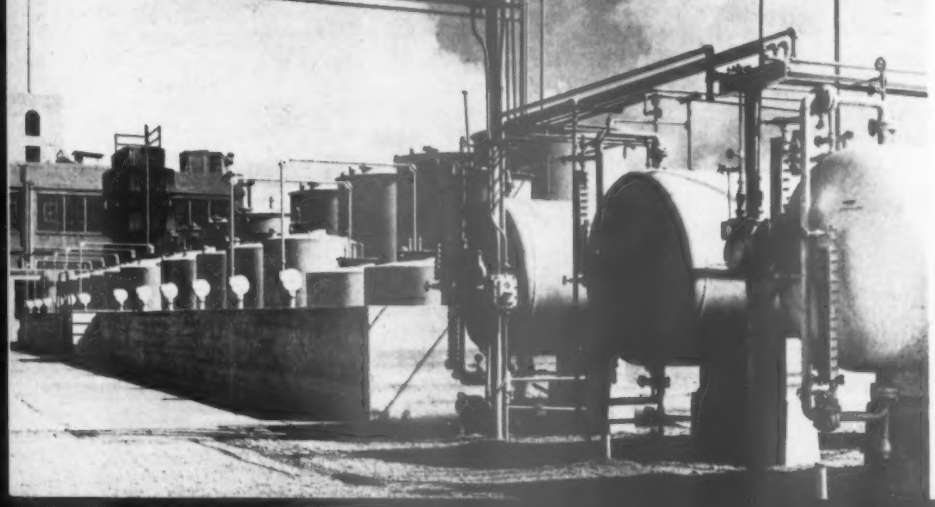
*Shell Development Co., Emeryville, Calif.

In smaller industrial organizations or those having a very limited development program, it is sometimes feasible to allow the original inventor to follow through on the subsequent steps of process development and commercial design with but relatively little engineering assistance. Such an approach can lead to very successful results, as the individual's enthusiasm tends to overcome the many disappointments and difficulties to be expected in such work.

However, it is rather unusual to find in a single man such diversified training and experience as to make him equally efficient at the laboratory bench and in the design and construction of commercial equipment. Furthermore, the development of the process from the laboratory to the commercial design often extends over months or even years, and the specialized training of the laboratory worker is thus lost during his period of concentration on a single problem. There is, therefore, a need in the larger organization for a separate group or department which will be responsible for the development of the process from the laboratory bench to the commercial design and for the co-ordination of the basic research with market development and the commercial design group.

This process development stage of the research program is an extremely critical one. If mistakes and high operating and maintenance costs are to be avoided in subsequent commercial operations, certain basic factors should be considered before undertaking a project.

The construction and operation of a



Bulk storage facilities for liquid and compressed gases at laboratories of the Shell Development Co., Emeryville, provide readily available supplies of feed stocks

pilot plant is comparatively expensive and time consuming, and usually involves a considerably larger number of men than the laboratory investigation. Therefore, only those problems which have a reasonable chance of eventual commercial application should be considered. The decision as to which projects should be undertaken, however, can be facilitated by first making a careful review of the status of the laboratory research investigation. Such review should preferably be independent of the initiating laboratory so that those responsible for the subsequent development steps are in a position to exercise independent judgment. The natural but often unwarranted enthusiasm of the inventor, particularly if he is aggressive, can lead to the adoption of a process which proves uneconomical or inadequately investigated in relation to other possibilities.

The opinion and prognosis of the sales or market development group is of particular importance at this point. However, their approach should be reasonably optimistic and open-minded. Picayunish objections should have no place in such decisions, and care should be exercised to maintain the enthusiastic interest of the laboratory research group. Data indicating the present and potential scale of outlets for the product should be carefully checked, since a high cost, low volume product may require a process approach entirely different from that for a low cost, large volume product. The larger the scale of the operation and the amount of capital expenditure involved, the greater is the need for accurate and careful process study. The initiating laboratory work should be carefully reviewed, and patent department opinion should be obtained as to related art and coverage afforded by the research work. Related patents or literature references should be checked lest their pertinency be accorded undue weight.

Following such a survey it may be necessary to return the project to the laboratory for additional study, or even drop the investigation. However, if the original conception was at all sound, it may merely require a change in the direction of attack. The fact that the project may not warrant process development in its initial form should not result in an executive decision to abandon all work on the subject if the field and objective appear fundamentally attractive.

In some instances it may be found that sufficient information and experience are available to permit commercial design without the necessity for further process development, but if the project appears to be suitable and ready for process development and pilot plant study, consideration should next be given to the method by which the problem is to be approached and the purpose or purposes the pilot plant is intended to serve. The problem may be to:

(1) Manufacture a new product for which no immediate outlet exists. In this case the pilot plant not only should be designed to provide engineering data but also should be of sufficient size to provide a ready source of material for use by the market development group. The preliminary consideration of this factor may eliminate the need for a second semi-scale plant or the premature construction of an uneconomically sized commercial unit.

(2) Provide a new method for the manufacture of a material having an already established market. Here engineering considerations can usually dominate and the scale of the plant be determined on the basis of the data required.

(3) Improve an existing process. This requires careful weighing of the advantage to be gained against the expenditure involved. Such pilot plant research is often necessary as insurance against obsolescence. To avoid "boondoggling" the objectives of the work should be carefully defined.

Design Considerations

Location. Examination of the purpose the pilot plant is intended to serve frequently will show that the amount of production desired will require a plant of a size more than sufficient to allow for all engineering considerations. This greatly simplifies design problems but may introduce difficulties as regards location and availability of feed stocks.

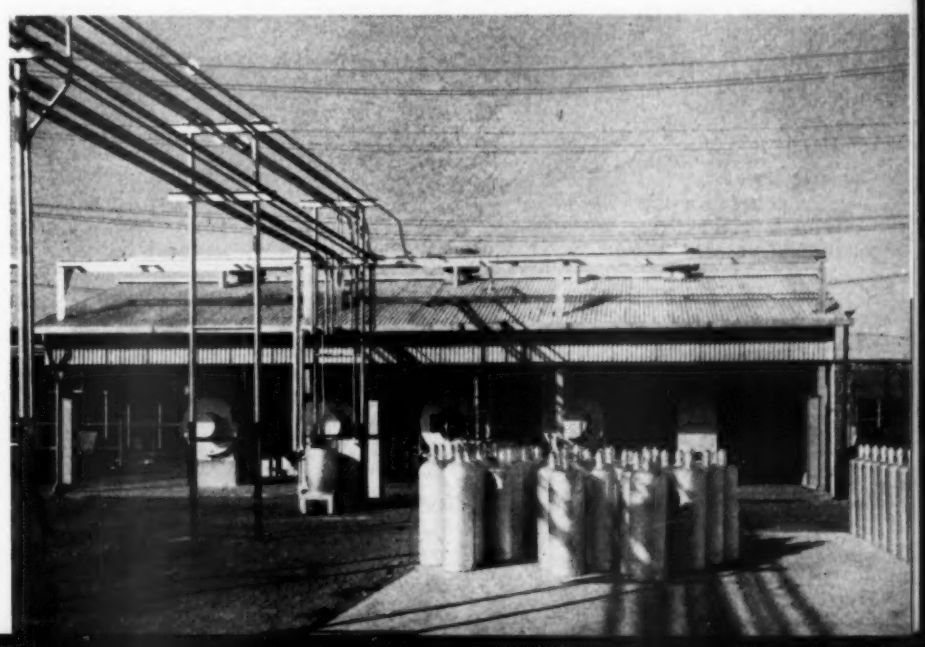
Where the development organization is located in or near the manufacturing plant, availability of the feed stock may not be a serious problem. However, in such locations, care should be taken to avoid a close tie-up with the operating unit. An otherwise excellent pilot plant program can be wrecked if it becomes the stepchild of a commercial unit; there is an inevitable conflict between objectives, and the pilot plant usually has to give ground because of economic considerations. The use of intermediate storage facilities and adequate surge tanks will help to eliminate some of these difficulties.

Many of our leading industrial research laboratories are located at some distance from their refineries or plants, but feed procurement is usually not a major difficulty except where non-condensable gases or materials difficult to transport are required. There is a definite advantage to locating the pilot plant adjacent to the laboratory in that laboratory facilities and staff are more readily available to the pilot plant group.

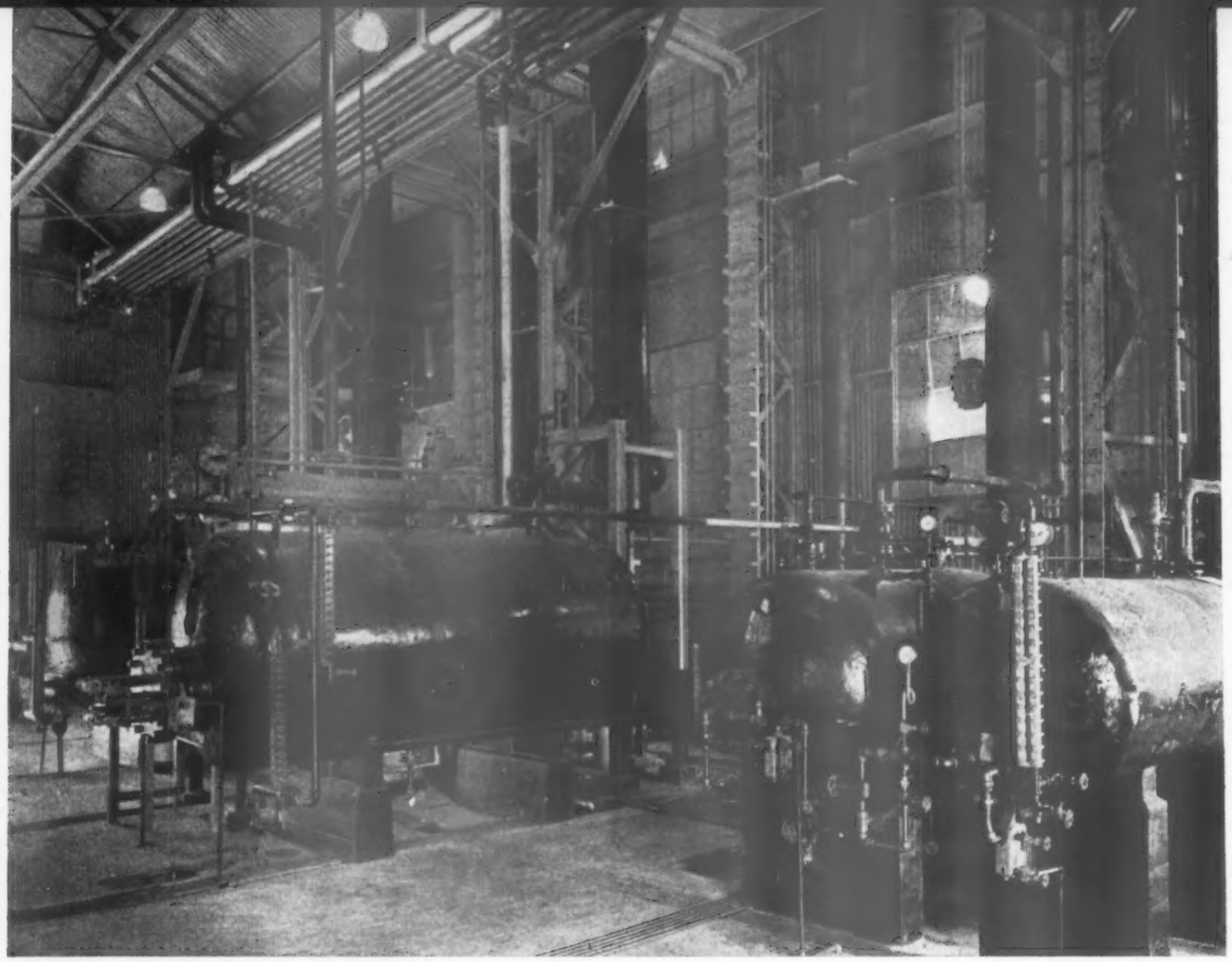
No blanket solution of the problem of location for the pilot plant can be given, but in the petroleum industry the problem is usually solved by maintaining a central process development group as well as supplementary groups at various refineries. Providing there is adequate liaison, this has proven to be very satisfactory.

Construction Materials. The preliminary laboratory research has usually been carried out in glass or in equipment differing from that available for commercial application. Before specifying construction materials for the pilot plant, it is desirable to check corrosion possibilities and the possible effect of metallic surfaces or dissolved metals on the yield and quality of the product. Certain metals may exhibit catalytic effects, and there are numerous examples of commercial plants where major revisions have been necessary, owing to a lack of proper appreciation of the limitations arising from corrosion. These difficulties have greatly increased under war conditions where substitutes often have to be installed against the better judgment of the process engineer.

Layout. There is a tendency on the part of some to consider the pilot plant as a model of what the commercial unit should look like based on the preliminary laboratory data. If such a model



Furnaces at Emeryville laboratories are placed separately for safety and convenience. Pipes for distributing materials are carried on easily accessible overhead stanchions



Broad planning of pilot plant facilities pays large dividends, lowers operating costs. At Shell's Emeryville laboratories most equipment is permanently located, such as the general distillation facilities shown above. Specific plant projects are then built up around this nucleus by addition of specialized equipment as required

plant is to be constructed, it is preferable to do it after the pilot plant program is completed and the commercial design is under way. The primary purpose of the pilot plant is to provide the necessary data for the construction of the most efficient and economical commercial unit possible. It is not intended to prove up preconceived ideas regarding design; if this is attempted, there is danger that the results might not turn out exactly as expected and thus time and money would have been wasted and a general feeling of disappointment and discouragement would prevail.

The pilot plant should be flexible in design rather than be scaled throughout for a perfect balance between individual units. In fact, it is usually desirable to divide the project into well defined segments so that better consideration can be given to the individual factors concerned. There may be sufficient data already available on certain steps in the operation so that such steps can be omitted or advantage taken of existing facilities. This is particularly true of recovery systems where a single batch still can often take the place of a number of continuous fractionating columns.

Critical parts of the plant should be overdesigned so as to permit flexibility; the operators will have enough headaches without being hindered by unnecessary mechanical bottlenecks. It is not sufficient to determine what happens under idealized conditions, and the scope of the operations must be broad enough to include conditions which are likely to be encountered in the full scale plant at times of faulty operation and during startups and shutdowns.

Provision should be made for an adequate number of sample cocks, handholes, look boxes, corrosion strips, and temperature and pressure recording and controlling devices. Many of these may prove to be unnecessary and can be eliminated in the commercial design, but the time to find this out is during operation of the pilot plant and not later when an expensive shutdown or addition to the full scale plant may be necessary. As accurate material balances are desired, extra weighing and measuring devices and intermediate storage and surge tanks should be provided. In addition, the pilot plant is likely to undergo frequent inspections and alterations; accessibility should, therefore, be given careful consideration in the layout.

As the pilot plant should be expected to undergo changes as dictated by the course of the development, the fact that the initial cost of the pilot plant does not cover the entire construction should be appreciated in advance by the management or it is likely to result in misunderstanding later.

As previously mentioned, pilot plant development and construction are relatively expensive; thus an effort should be made to take advantage of existing facilities whenever possible. This may not be practicable if the development program of the company is limited to only a few projects, but where a long term program covering a number of subjects is contemplated, broad planning of the pilot plant facilities will pay large dividends.

An example of this latter treatment is the pilot plants of Shell Development Co. at Emeryville. Here most of the equipment is permanently located to form a nucleus around which the pilot plant projects are created by adding the items peculiar to the problem at hand. At the completion of a given pilot plant project the specialized equipment is removed and returned to storage, where it is reconditioned for future service. If the principle of flexibility is maintained in the purchase of new apparatus, most of such equipment can be salvaged. Thus once the initial investment was made, new projects could be undertaken quickly and at relatively low cost.

Attention to appearance should be given in the pilot plant layout. There is no reason why such plants should look like piles of junk to be tucked away in some corner where it is hoped that they will not be seen; better results

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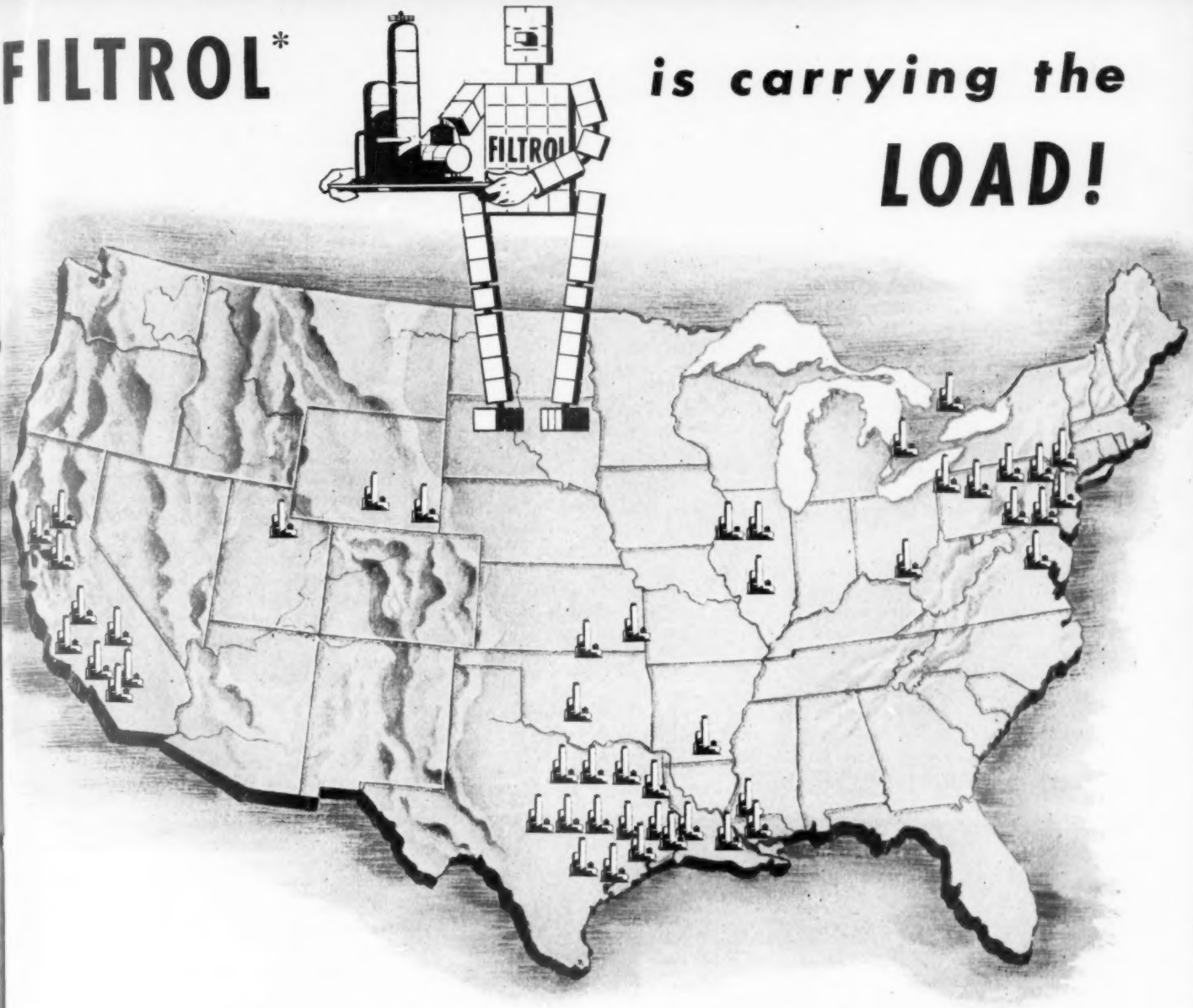

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and safer operation usually issue from a neat, well-designed plant.

Equipment. It is not within the scope of this article to cover specific recommendations of equipment for a single project; a few general considerations, however, may be of interest.

The equipment of the pilot plant should be carefully chosen in order to insure that translation of the design to a larger scale will not involve fundamental changes. The use of "trick" layouts adaptable only to small scale equipment should be avoided.

Certain chemical engineering data should be obtained prior to ordering the pilot plant equipment; this will assist in the avoidance of unsuitable apparatus. Where heterogeneous mixtures are involved, mixing studies are of vital importance since the rate of reaction and heat absorption or evolution may well depend upon the degree of agitation afforded, and translation of scale may result in serious complications. This is also one of the most frequently overlooked factors in the laboratory. Unfortunately a great deal of the knowledge on this subject is empirical.

Thermal data should also be given preliminary consideration, particularly where the heat of reaction is large, as they may greatly influence the choice of equipment.

Whenever possible it is desirable to select equipment which can be salvaged or reused, as this will tend to reduce individual plant costs and will greatly expedite construction, especially under present war-time restrictions.

Those responsible for pilot plant design should build up a library of equipment manufacturers' catalogues and should maintain close touch with manufacturers' representatives. Operations which were virtually impossible a few years ago have become practicable as the result of progress in the equipment field; recent developments have been exceedingly rapid, and they are likely to continue as the result of war-time stimulus. Naturally, some of the claims made by the equipment manufacturers may not be substantiated in practice and one's approach should, therefore, be critical; but the pilot plant is the place to try new ideas so that advantage can be taken of them in the commercial design.

It is essential for the process development group to have ready access to good shop facilities. In the larger organizations, where the total amount of work is relatively steady, these facilities should be independent of those connected with commercial operations so as to avoid any conflict with such operations. Time lost in making necessary equipment changes is one reason, if not the major reason, why pilot plant investigation is often so time-consuming and expensive.

Personnel

The individual responsible for pilot plant design, construction, and operation should be an experienced chemical engineer or a chemist with a process engineering background. He should not be subordinated to the other research groups but should report directly to the director of research and development or to a higher administrative officer. The pilot plant operation provides a check on laboratory results and this check should be an independent one. However, the closest possible co-operation with the research and engineering groups is essential. The pilot plant department head should be thoroughly grounded in research laboratory techniques so that he can appreciate the research staff's point of view and have their confidence in his decisions. He should also be familiar with manufacturing problems, operations, and facilities of the operating company so that the proposals emanating from the development organization will fit into their plans and will be acceptable to them.

The process development group should be adequately provided with laboratory facilities and a staff specifically assigned to this work.

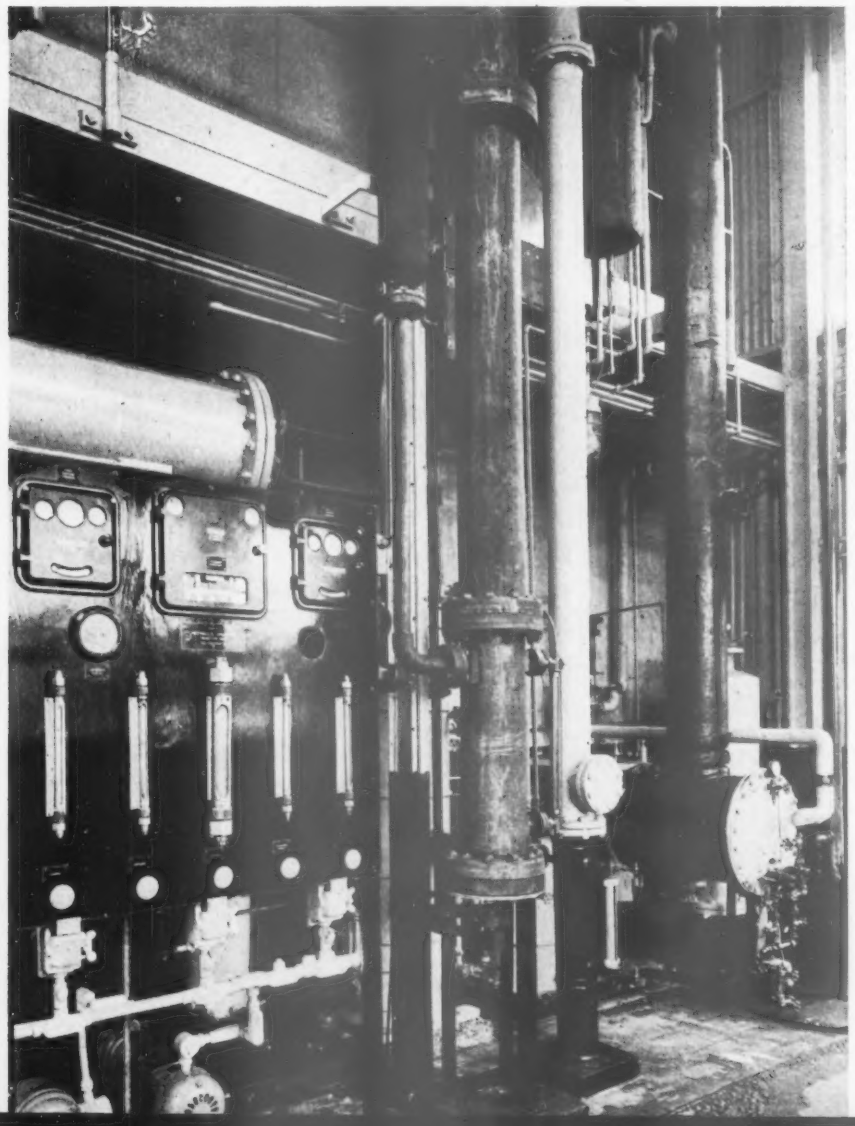
The experimental operating personnel should include a number of technically trained men capable of accurately assessing sources of difficulty and making the necessary corrections.

Chemists and chemical engineers involved in the process study should be complemented by mechanical engineers and draftsmen, and have the backing of an adequate staff of skilled mechanics.

One of the major difficulties confronting the pilot plant management arises from the fact that by the time the potential process has reached this stage, the interest of others has been so aroused that there may develop a tendency to pressure and rush the program or to do unwarranted "short cutting". This tendency is only human, but it can be extremely troublesome. The author's advice to the person in charge of the work is to give honest consideration to all suggestions and to cultivate a sense of humor, but to remember that in the end he is the one who will be held responsible for the program.

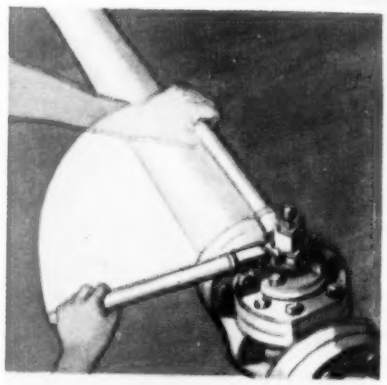
Acknowledgment

The author wishes to thank Shell Development Co., for permission to publish this article outlining his personal views on the organization of pilot plant research.



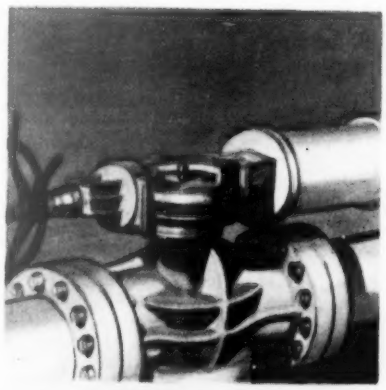
A typical pilot plant reaction unit at the Emeryville laboratories, used for manufacturing methallyl chloride

Does TIME *mean anything to you in valve operations?*

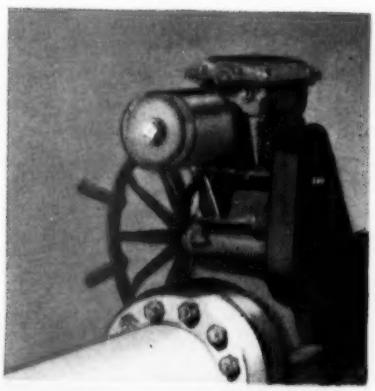


QUARTER TURN
FOR SIMPLICITY OF CONTROL

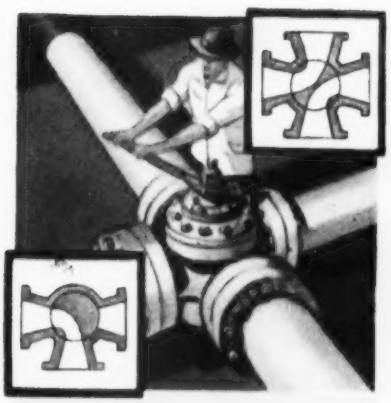
QUICK GEAR OPERATION
FOR HEAVY DUTY SERVICE



CYLINDER OPERATION
FOR AUTOMATIC CONTROL



ELECTRIC MOTOR OPERATION
FOR REMOTE CONTROL



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KEEPING UP WITH THE NEWS

New Developments in Scientific, Industrial and Economic Fields Reviewed with Comment as to Their Possible Future Effect on the Petroleum Industry

*By N.P.N. Special Writer**

The first two articles in this series have dealt with numerous subjects which pertain to present and future problems and to processes of importance to the petroleum industry. In these articles, as in the present one, the object has been to discuss those current news items reported in the columns of scientific journals which are of such nature that some elaboration upon the outline of the news may prove of aid to the petroleum industry in weighing their importance.**

New developments come very quickly to a field as broad in significance as the petroleum industry. This has been especially true since the advent of the war, but the necessity for censorship has imposed a barrier before the publication of many pertinent developments. It is therefore of importance to each petroleum technologist to keep abreast of all developments that may be discussed so that he may be able to use his knowledge the better to understand and to take advantage of all that will be disclosed at the end of the war.

The author of this series is a chemical engineer in the research subsidiary of one of the large oil companies; his duties include a continuous survey of the current technical journals in the many fields related to the petroleum industry.

Diesel Fuels From the Synthine Process

Often overlooked in a discussion of petroleum substitutes are products other than gasoline. Nevertheless, production of fuel oils, lubricants, waxes, and hundreds of petroleum specialties will be of considerable importance in determining the future status of any process for the production of petroleum substitutes, since the role of these products in our modern world is probably as important as that of gasoline, although their applications may not always be as visible.

Of special interest to petroleum refiner and industrial consumer alike is the little-publicized fact that the Synthine (Fischer-Tropsch) process is a source of Diesel fuels which far surpass any made from crude petroleum. As mentioned in last month's article[1], the Synthine process involves the catalytic hydrogenation of carbon monoxide, the intermediate gases (hydrogen and carbon monoxide) being obtainable from either natural gas or coal, with immediate economics favoring the former source and natural resources overwhelmingly in favor of the latter.

It has recently been revealed[2] that the Navy Department is making tests of a new high-cetane Diesel fuel which gives promise of producing revolutionary results in augmenting or improving the present fuel supply for many Diesel ships in the fleet. From the description of this fuel and its raw materials (natural gas), there can be little doubt that the Diesel fuel in question is that produced by the Synthine process.

As Dr. H. H. Storch, Principal Physical Chemist of the Bureau of Mines, recently told the O'Mahoney Senate subcommittee[3], "the highly paraffinic nature of the Fischer-Tropsch oils—is of great value to their use as Diesel oil. The Diesel oil boils in the range, 200°-300°C. (412°-572°F.) and has a cetane value of over 100; even when diluted with an equal volume of tar oils or heavy petroleum oils the resulting mixture is a satisfactory Diesel fuel." Dr. Storch went on to say that the process, as practiced in Germany in 1939, gave products which contained 26 per cent of these oils.

According to another source, primary products are said "to contain about 22-23% of high-quality, 100-cetane number Diesel oils. This material can be blended with 60 to 70% of low-cetane-number petroleum oils to produce a 50 to 60 cetane number Diesel fuel. By mild cracking of Fischer-Tropsch wax, it is also possible to produce a Diesel fuel fraction of about 85 cetane number."

According to a survey of the literature, a Diesel oil fraction obtained from Synthine primary products by simple distillation has a boiling range of 200°-360°C.; a specific gravity (at 20°C.) of 0.769, a hydrogen content of 15.2 per cent, and a heat of combustion of 18,900-20,300 Btu per pound. Even those modifications of the process which yield primary products of higher olefin content (desirable for the production of higher octane motor fuels) are said to give Diesel oil fractions (200°-300°C.) of 81-86 cetane number, which Diesel fuels may be still further improved by hydrogenation.

A serious drawback to the use of straight Synthine Diesel fuels is their high solidification point, said to be around 2°C. (36°F.). It is probably for this reason that these fuels are used abroad in blends with low-ignition-quality aromatic tar oils or hydrogenated oils, whose cetane number they greatly improve, as mentioned.

The cost of Synthine Diesel fuels is at present indeterminable, although certainly somewhat higher than that for petroleum-derived Diesel fuels. It is not so much higher, however, nor is the process so well developed that drastic improvements are unlikely, that these fuels can be relegated to the category of distant potentialities. In fact, some of the rumors concerning the erection of Synthine plants after the war by the petroleum industry, using natural gas, state that premium Diesel fuels may for a time be the chief product, since much experimentation seems still to be required before competitive grades of gasolines can be produced.

While not connected except by implication with Synthine Diesel fuels, it is of interest to note that The Texas Co. is reported[4] to be planning the construction of an $880,827 pilot plant for the Synthine process at its Los Angeles refinery. Many more such announcements can be expected, since several companies are known to have conducted extensive research in this field prior to the war, and some of this research has been continued. The work to be done by the Bureau of Mines on this process, as part of the five-year program authorized by Congress, will also bear attention.

The increasing amount of literature

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[1] NATIONAL PETROLEUM NEWS 36, No. 31, R-564 (1944), "Gasoline From Coal."

[2] Anon., NATIONAL PETROLEUM NEWS 36, No. 32, 13 (1944), "Navy Hails New High-Cetane Fuel From Gas Synthesis."

[3] "Synthetic Liquid Fuels," Hearings on S. 1243, August 3, 4, 6, 9, 11, 1943, Superintendent of Documents, Washington, 1943, p. 206.

*The author is a chemical engineer on the research staff of one of the oil companies.

**NATIONAL PETROLEUM NEWS, TECHNICAL SECTION 36, No. 27, R-420; No. 31, R-563 (1944).

[4] Anon., *Chemical & Metallurgical Engineering* 51, No. 7, 210 (1944), "New Construction—Proposed Work."

on the subjects of compression-ignition engine fuels, methods for improving their ignition (and other) qualities, and economic interpretations of the trend toward use of the best petroleum stocks for catalytic cracking to gasoline bears testimony to the importance of seriously considering such a new method of making high cetane fuels as the Synthine process.

One of the chief merits of Diesel fuels has long been its low cost (partially because of a lack of tax collection even when sold for vehicular use). This, along with higher thermal efficiencies in operation, has created an ever-increasing scope of application for the Diesel engine, which in turn has been so developed that many present types require fuels of ignition qualities hard to obtain.

While the use of Synthine Diesel fuels does not appear to promise lower costs, nor, necessarily, higher efficiencies (since cetane numbers are not directly comparable to octane numbers in significance), it does seem to offer a new way to get high-ignition-quality fuels, if these are required, without upsetting the balance of refinery operations now slanted toward ever-increasing gasoline yields.

Postwar Motor Gasoline

Published under the above title, a survey of expert opinion compiled from the literature of Alberta H. Adams and B. H. Weil of the Gulf Research & Development Co. has recently made its appearance[5]. The summary and many of the details of this article, which is a revised edition of a paper presented in April before the Petroleum Division of the American Chemical Society, are of definite interest to the petroleum industry, which must gauge its postwar markets as accurately as possible so that it may prepare for the day of reconversion.

In their summary, the authors state that: "Consensus among automotive and petroleum experts indicates that some 20,000,000 of the nation's prewar nearly 30,000,000 cars will remain in operating condition at the war's end, maintaining, with the help of some military consumption and increased commercial and farm use, a volumetric market for gasoline of at least 75% of the prewar level.

"A rapid recovery to or above normal prewar use is expected to follow as new tires and cars come into production. The immediate postwar cars will probably be the 1942 models, with changes in automobile design expected to come slowly. One hundred-octane fuels are not expected to be required for some years, if ever."

The paper itself contains numerous interesting conclusions, derived from the statements of authorities. It is said that "a period of ten months is about the highest reasonable estimate for complete recovery from war-caused (tire) shortages; even this may prove too high if the anticipated lag between cessation of hostilities in Europe and that in the Far East become a reality."

Much recent opinion on transitional and postwar automobile designs is presented, it being concluded that plastics and the light metals will play an important role in future cars but not necessarily to the extent of replacing the steel body and conventional frame.

The octane number estimates which the authors found to be most generally predicted were ranges of 78-80 A.S.T.M. for regular gasoline and 85-88 A.S.T.M. for premium grade fuels.

The authors deal with an admittedly speculative subject in their discussion of the number of operable cars which will be in existence at the end of hostilities. They refer to recent estimates released by the General Motors' Chevrolet Division, which state that the number of cars expected to be on the road in July, 1945, will be between 21,150,000 and 21,300,000, and to some figures of C. L. Burrill's[6], who believes that a low in cars in use of 23,169,000 will be reached by Jan. 1, 1945, after which he expects resumption of production and the removal of cars from dead storage to increase the number on the road.

A more pessimistic estimate on this subject has recently been published[7]. Public Roads Administration figures are said to show a drop in registration in 1943 to 25,912,730 passenger cars and 4,586,878 trucks and buses, a total of 30,499,608. This year's total is expected to decline to 23,000,000 cars and 4,200,000 trucks, and it is postulated that the prewar auto pool in use in 1945 can be expected to shrink to 20,000,000 cars and less than 4,000,000 trucks and that not more than 2,500,000 new vehicles are likely to be added in that year.

W. S. James, Chief Engineer for the Studebaker Corp. and President of the Society of Automotive Engineers, is more optimistic[8]. He states that only 1,497,000 cars were junked in 1942, only 879,406 in 1943, and that the rate of scrapping continues to decline. An extrapolation of his figures would yield an estimate of 25,000,000 to 26,000,000 cars in operable condition at the end of the war, since less than 3,000,000 of the 29,601,774 passenger cars registered in 1941 will have been junked in 1942, 1943, and 1944. James stated that scrapping figures of 2,000,000 to 2,400,000 cars per year, based on registrations, were much too high because they did not allow for cars put into storage.

In any case, it would appear that the petroleum industry can safely count on at least 20,000,000 operable passenger vehicles at the close of hostilities, as Adams and Weil concluded, and, as they stated, "estimates of immediate postwar fuel requirements for passenger cars—will approximate 75% of the prewar volume (the reduction in demand being less than proportionate to the number of cars lost because many of those lost will be of the 'marginal' type which normally sees comparatively little operation)."

Plastics from Petroleum

Three recent new items bear testimony to the trend toward the use of petroleum hydrocarbons in the synthesis of plastics. The first of these is an announcement that WPB has authorized the Shell Union Oil Co. to construct an allyl chloride and allyl alcohol plant at Houston.

As revealed in numerous publications and patents on the synthesis of glycerine from petroleum[9], Shell has done much research and pilot-plant work on these intermediates, which it synthesizes from propylene. Propylene of 98% purity is directly chlorinated at 500°C. to give allyl chloride "in yields on the order of 85%." A large excess of propylene over the theoretical amount is used, in order to avoid production of di- and trichlorides and to aid in temperature control.

To make allyl alcohol, which incidentally is the next intermediate required in the glycerine synthesis, allyl chloride is hydrolyzed, preferably in alkaline solutions. Yields of 90 to 95% were reported by Shell, which found temperatures of 150 to 160°C. and pressures of about 200 p.s.i. satisfactory.

Allyl chloride "is a versatile compound well adapted for synthetic work.—At present (1940) allyl chloride is being used for the synthesis of derivatives such as the alcohol, the isothiocyanate (mustard oil), barbiturates, amines, and cyclopropane. Allyl alcohol is readily oxidized to acrolein—which can lead to a wide variety of compounds. The polymers

[5] Adams, Alberta H., and Weil, B. H., *Chemical and Engineering News* 22, No. 14, 1154 (1944), "Postwar Motor Gasoline."

[6] Burrill, C. L., NATIONAL PETROLEUM NEWS 36, No. 10, 33 (1944), "New Peaks in Fuel Consumption and Auto Output Forecast by 1950."

[7] Anon., *Business Week*, No. 778, 21 (July 29, 1944), "How Registrations Slumped."

[8] Lamm, Earl, NATIONAL PETROLEUM NEWS 36, No. 28, 19 (1944), "New S.A.E. President William S. James Doubts Extreme Stylism in Early Postwar Cars."

[9] Williams, E. C., and Associates, *Chemical & Metallurgical Engineering* 47, 834 (1940); 48, 87 (1941), "Synthetic Glycerine From Petroleum."

of acrolein, of course, are well known. Allyl esters are prepared easily from the alcohol and are used for the manufacture of perfume and *resins*."

Two new plastics based on allyl alcohol were announced in 1942. Shell itself announced a polymer of diallyl phthalate, said to be excellent for such uses as coatings for cans (coatings being able to withstand temperatures of well over 500°F.). Production, however, was going to certain unrevealed war uses.

The other plastic, a "plastic glass" said to be "20 to 30" times harder, presumably in abrasion resistance, than any other clear plastic and less brittle and harder than glass, was developed by the Pittsburgh Plate Glass Co. First called "C.R.-39" and now titled "Allymer-39," it was at once proposed for use in transparent inserts, turrets, and "green houses" on fighter and bombing planes, but it was stated that the chief difficulty in the way of large-scale production was the shortage of allyl alcohol.

An article on aircraft uses of transparent plastics[10] which appeared in 1943, however, indicated that limited quantities were being used. Comparative properties were discussed.

It seems likely, from the recent announcement, that most of the allyl alcohol produced will go into the manufacture of these and other types of allyl plastics, now used exclusively for military (chiefly aircraft) purposes. After the war, according to the announcement, Shell intends to diversify its allyl products to include numerous "chemicals." The allyl group, chemically, offers potentialities rivaling those of the vinyl group. It seems very likely that much will be heard about allyl products after the war, especially if costs are reduced, as seems likely.

Polyethylene Plastics

It so happens that the second recent news item concerning plastics from petroleum deals with the most familiar and abundant source of the above-mentioned vinyl group—ethylene itself. Obtainable from the gases of cracking operations or by deliberate synthesis from ethane, propane, and heavier petroleum fractions, ethylene is the chemical raw material for many—almost "most"—of the chemicals now being derived from petroleum.

There was considerable interest in the early days of the war in a British announcement that Imperial Chemical Industries, Ltd., was producing a plastic from ethylene by direct polymerization. Called Polythene, generically, and sold in England under the registered trade name "ALKATHENE," the substance is "more or less elastic in nature and belongs among the so-called elastomers or resinous compounds possessing rubber-like properties[11]". Possessing excellent insulating characteristics, Polythene was being used by the British "for the manufacture of cable sheathing, especially since the war has shut off British imports of German polyvinyl chloride formerly used for this purpose."

As confirmation of rumors heard last year, also, was the announcement in January of this year that E. I. du Pont de Nemours & Co. was producing Polythene domestically from petroleum ethylene, using I. C. I.'s process.

Polythene is flexible and tough over a wide range of temperatures, has unusually good resistance to water and to penetration by moisture, has good chemically inertness, and possesses excellent electrical properties. According to du Pont's announcement, production at present is allocated entirely to war uses.

Polyethylene plastics are thermoplastic; may be molded by compression, injection, or extrusion; and can readily be produced as strings, films, or tapes, or used to cover wires and cables. Polythene is said to look much like gutta percha. These plastics are said to retain their flexibility at rather low temperatures.

All of this lends unusual interest to the announcement in July[12], released by permission of the Navy Department, that the Carbide & Carbon Chemicals Corp. has, for over a year, been producing polyethylene plastics for the insulation of coaxial cable used in Naval radar equipment.

According to this announcement, Carbide & Carbon, in collaboration with an associate, the Linde Air Products Co., has developed a high-pressure synthesis of this new material, using "a process different from any other commercial polyethylene process." Its plant produced at a rate of 240% of rated capacity for the first year of production and is now said to be producing at a rate of 600%.

The fact that two of the largest chemical companies in the U. S. have both developed processes and built plants for the production of polyethylene plastics seems to indicate that these substances are potential rivals or co-workers of the other members of the plastics family. Future developments should be watched with interest as should all uses of new materials which use petroleum as a base.

Phthalic Anhydride

The third of the news items concerning plastics from petroleum has to do with new facilities for the production of phthalic anhydride.

Phthalic anhydride is a raw material for the production of the alkyd resins, vital materials for coating purposes during this war and substances which had already been used to the extent of many millions of pounds per year before the war. Phthalate esters are also used as important plasticizers for other plastics and are used in smokeless powder. So critical has the situation become that, in May, WPB had to place new restrictions on even military uses of the alkyd resins.

According to statistics from various sources, some 113,067,286 pounds of phthalic anhydride were produced in 1943, while the production of alkyd resins (from other sources, as well) was somewhat less than 170,000,000 pounds. Early this year the 1944 forecast for the alkyd resins was placed at 170,000,000 pounds.

In June, WPB, in requesting an increase of 12,000,000 pounds in capacity for the production of phthalic anhydride, revealed that the scheduled production for 1944, 126,000,000 pounds, falls far short of demand. It was said that facilities to be completed by the second quarter of 1945 would bring production to a rate of 165,000,000 pounds per year but that the additional 12,000,000 pounds will be needed to balance supply and demand.

To accomplish this result, WPB has recently authorized the construction of three plants to produce an additional 21,000,000 pounds per year. Two of these, presumably of the conventional type using naphthalene from coal tar as a raw material, will be built near Pittsburgh by the Koppers Co. and the Pittsburgh Coke and Iron Co., but the third plant is to be built in the San Francisco Bay area by the Standard Oil Co. of California.

This latter plant, perhaps, may produce phthalic anhydride from petroleum hydrocarbons, possibly by some new process. Several theoretical chemical paths may be followed, but none has hitherto been used commercially.

Phthalic anhydride and its chief derivative, the alkyd resins, are somewhat uncertain prospects for the postwar period. Military demands for coating materials will certainly decline greatly when the production of implements of war is decreased or discontinued, and it may be several years before civilian uses mount high enough to utilize available facilities. Nevertheless, it would appear that another commercial entity is being added to the list of chemicals from petroleum.

The president of the Tide Water Associated Oil Co. recently said in his report to the stockholders of that company:

[10] Brown, O. E., and Arata, W. H., Jr., *Modern Plastics* 21, No. 2, 89 (1943), "Transparent Enclosures in Aircraft."

[11] Wakeman, R. L., "Plastics and the Gas Industry," American Gas Association Meeting, 1940.

[12] Anon., *Oil, Paint and Drug Reporter* 146, No. 3, 44 (1944), "Polyethylene Needs of Navy Met by Carbide and Carbon."

"The field of petroleum chemistry is of extreme interest to this company. It involves the manufacture of organic chemicals from gaseous and liquid petroleum hydrocarbons available from refinery and gas cycling plant operations. This field appears to have an important future, particularly in the postwar period."

The same interest is being evidenced by many other companies.

Antifreeze

Even in normal times, antifreezes are of considerable importance to the petroleum industry. Vital to the winter operation of the automobiles which use petroleum products, and often made from petroleum raw materials, these substances are sold in almost every filling station throughout the land.

Since the beginning of the war, ethyl alcohol antifreezes have regained control of a field which they dominated years ago but which in recent prewar years was ruled by methanol and isopropanol antifreezes and by those of the so-called "permanent" type, usually consisting of ethylene glycol. Ethylene glycol antifreezes have been used almost exclusively for aviation purposes during the war, however, and methanol has been going great quantities to the synthesis of formaldehyde, vital to the plastics industry.

Ethyl alcohol, while not perhaps as good an antifreeze on a gallon for gallon basis as these latter materials, was substituted for them because its output, even though badly needed for the manufacture of smokeless powder and synthetic rubber, could be greatly increased by converting the beverage alcohol industry to the manufacture of 190-proof industrial alcohol, as was done.

According to WPB figures, 29,000,000 gallons of 190-proof alcohol were used as antifreeze in 1942, and 49,000,000 gal. were consumed for that purpose in 1943. In the latter year, almost all of the antifreeze market seems to have been taken, although limited quantities of ethylene glycol types were made available.

WPB plans for 1944 call for the allocation to antifreezes of only 30,000,000 gal. of ethyl alcohol, however, although it is said[13] that "motor cars need 60,000,000 gal. a year of antifreeze." The rest of whatever quantity is required, evidently, "will be filled almost exclusively by glycol and methanol," especially the latter.

This is said to be possible because large-scale production of methanol has recently been started in Government-owned facilities built for the synthesis of ammonia for munitions manufacture but not now required for that purpose because of overplanning.

Synthetic methanol and ammonia facilities are very similar, both being of the high-pressure type, and in the early days of the war a certain portion of synthetic methanol facilities were actually converted to the manufacture of then-scarce ammonia; the present plan is the reverse of this.

Most of the synthetic ammonia plants built during this war seem to be government-owned and industry operated. In the majority of these, natural gas is used as the raw material for hydrogen manufacture, conducted either by use of the catalytic methane-steam reaction or by high-temperature pyrolysis in regenerative furnaces. Most of the plants were announced in 1941[14]. According to a recent article[13], "it looks as though methanol production before the end of 1944 will be at a rate in excess of 100,000,000 gal. per year. At mid year the output was 75,000,000 gal.

Methanol, volume for volume, was said to be the most efficient antifreeze on the prewar market, although of course it was not of the "permanent" type. Its price made it definitely competitive even with prewar ethyl alcohol from cheap blackstrap molasses; it is probable that new facilities (some have been built directly for its manufacture) will bring its cost still lower. Du Pont, for example, recently announced a price of 23 cents per gallon in tank car lots, f.o.b., Belle, West Virginia; prior to the war it never sold on the market for less than 30 cents per gallon.

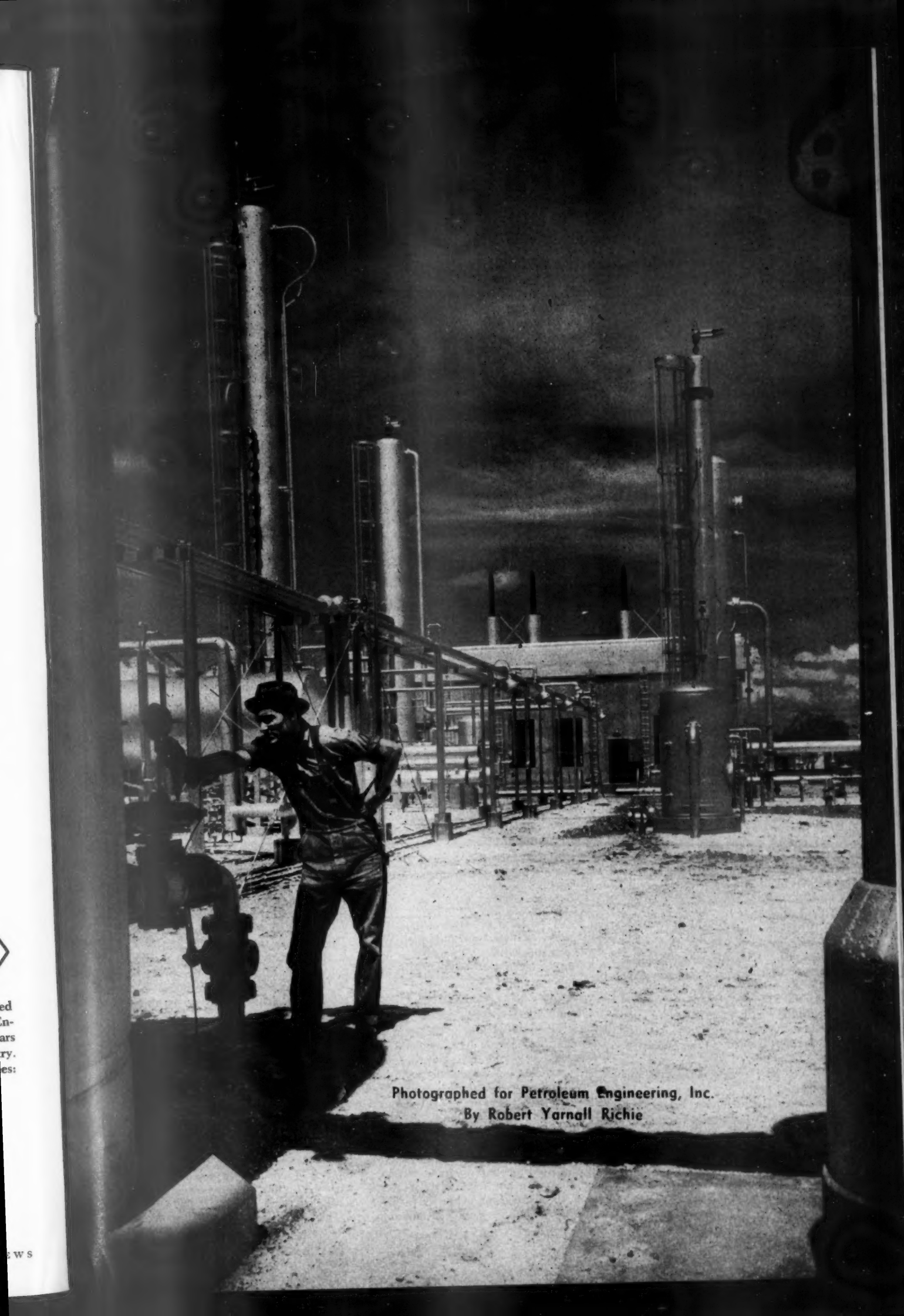
Methanol synthesis is closely linked to the petroleum industry in yet another way. Its intermediate materials, carbon monoxide and hydrogen, are also the raw materials for the synthesis of Synthine products, using different catalysts and much lower pressures. Thus plants erected to produce hydrogen for ammonia by the catalytic methane-steam reaction are equipped to manufacture the raw materials for either methanol or Synthine products, since all that has to be done is to halt the process half way (the normal procedure for maximum hydrogen production involving further catalytic hydrolysis of the carbon monoxide also produced in the first step).

Chemical economics have a way of becoming highly involved, hence it is not too surprising to find oneself considering antifreezes, ammonia, synthetic petroleum, plastics, and smokeless powder all in one breath. Despite the complexity of the situation, it now seems likely that automobiles next winter will not run short of antifreezes; this is the first time during the war that this statement seems safe.

[13]McBride, R. S., Wooton, P., and Burton, M., *Chemical & Metallurgical Engineering* 51, No. 7, 84 (1944), "Watching Washington—Shift in Antifreeze."

[14]Anon., *Chemical & Metallurgical Engineering* 48, No. 11, 138 (1941), "Ammonia Shortage."

A view of one of many plants designed and constructed by Petroleum Engineering, Inc., in the past 15 years of continuous service to the industry. Petroleum Engineering, Inc., Offices: Tulsa and Houston.



Photographed for Petroleum Engineering, Inc.
By Robert Yarnall Richie

THE MAINTENANCE and REPAIR of REFINERY TURBINES

The Program Instituted at a Large Gulf Coast Refinery Includes Complete Rebuilding by Company Mechanics

*By Gilbert G. Coombs**

OPERATION of the Pan American Refining Corp's. Texas City refinery commenced in 1934 with one combination thermal cracking unit and auxiliary equipment. About one-half of the pumping installations were steam turbine driven, and turbine difficulties were almost immediately experienced. With a new steam plant in operation and water treatment below the high standard later achieved, deposits in turbine blading reached serious proportions. To add to the problem, corrosion of wheels, blading and shafts was encountered, and unbalanced rotors caused severe headaches among those responsible for maintenance of this equipment.

These difficulties were overcome with surprisingly small losses in operating efficiency and the headaches were not without compensation; for these troubles formed a foundation on which was built a training program to enable the refinery mechanics to make major repairs to turbines of numerous types and sizes. Today, with over 250 turbines in the plant, ranging from 5 hp. to 4000 hp., turbines are completely rebuilt by refinery mechanics and calls for manufacturers' service engineers are rarely necessary.

Experienced Mechanics Necessary

There appears to be a widespread belief, probably encouraged by turbine manufacturers in prewar days, that major turbine repairs should be handled solely by factory-trained experts. It is recognized that modern high speed turbines are precision machines, and it is freely acknowledged that poor workmanship or ill-advised repair methods can produce disastrous results. The plant which does not possess mechanics of adequate ability would do well to avoid these risks. However, there appears to be no sound reason why men with years of experience in other branches of precision mechanical work cannot be trained in the repair of turbines.

The re-building of multi-stage, high speed centrifugal pumps, which is commonly handled by refinery shops, involves considerable precision work, on machine tools and on the assembly floor. Mechanics who perform such work should be no less capable of similar precision applied to turbine repairs.

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When the turbine manufacturers are convinced that the reputation of their machines is not to be jeopardized by questionable workmanship or methods, they will be found to be co-operative in the matter of suppling replacement materials. In these busy times they are no doubt pleased to be relieved of some of their normal field work and factory overhauls.

It is proposed to outline in this article the general procedures followed at the Pan American refinery for turbine maintenance and repair, in the hope that it will prove of interest and benefit to smaller plants which have perhaps been reluctant to tackle this problem with their own forces.

A training program to enable refinery mechanics satisfactorily to repair turbines of various types and sizes is in operation at the Texas City refinery of Pan-American Refining Corp. Maintenance and repair work is based on systematic inspection, turbines being opened for inspection every two years as a general rule. Detailed records are kept of conditions encountered and repairs made.

To illustrate how the program works, a major repair job on a 355-hp., 6-stage, condensing turbine is described step by step. Differences in design and materials of turbines are also discussed to the extent they affect the methods used and precautions adopted.

As with any maintenance and repair program which is expected to operate successfully, this work is based upon systematic inspection. In general, turbines are opened for this purpose every two years, varying somewhat according to size, type, service, and recent history. Tabulations of turbines in each process unit, power station, and pump-house show at a glance the date of the last inspection, and detailed records are maintained of conditions encountered and repairs made. This procedure permits advance scheduling of major repairs, the requisitioning of replacement materials to forestall service failures, and a minimum down time for urgently needed equipment. The form used for inspection records is shown in Fig. 1.

Perhaps the best way to describe the methods used for a major turbine repair would be to follow in detail such a job from start to finish, using for example a turbine which was recently overhauled. Following the analysis of this turbine repair, a few differences in design and materials of turbines will be discussed, to the extent that they affect the methods used and precautions to be observed.

The machine to which reference has been made is a 355 hp., 6-stage, condensing turbine, having an operating speed of 4320 RPM and driving a centrifugal water pump through a reduction gear. The turbine had been opened for inspection about one year previously. At that time corrosion of the wheel blading and reversing buckets had progressed to such an extent that a complete re-blading job was decided upon, and the necessary materials were ordered.

Guide Bolts Hold Alignment

Prior to lifting the casing cover, four long guide bolts are secured through the cover bolt holes to the parting flange of the casing. By this means the cover is maintained in alignment while being raised, and damage to the wheel blading and reversing buckets is avoided. After removal of the cover, bearing caps and upper halves are dismantled, the flexible coupling is parted and the rotor is lifted from the casing. This operation is performed with great care, in order to avoid tearing the wheel blading shrouds. The rotor is then lifted by a rope sling at the journals and conveyed to the machine shop by means of a winch truck. It is unwise to permit a heavy turbine rotor to rest upon the wheel blading, for obvious reasons.

Upon arrival at the shop, the governor gear is removed from the shaft, and the rotor is placed in vertical position with the coupling bolted solidly to a floor plate. The latter is a heavy steel plate secured to a concrete foundation, the face being flush with the floor and containing tapped bolt holes of various radii to permit clamping of the work. On a monorail directly over the turbine rotor is a chain hoist for handling the wheels as they are removed from the shaft.

The six wheels of this particular tur-

bine are assembled upon the shaft with a light shrink fit, being restrained from axial movement by an integral collar at one end, a nut threaded on the shaft at the other end, and spacer sleeves between the wheels. After the retaining nut is removed, preparations are made for heating the first wheel, in order to expand it sufficiently to permit lifting from the shaft. For this operation, a circular gas burner is employed. This device is readily fabricated by bending a piece of ¾-in. pipe to a diameter about one-half that of the wheel, and drilling a number of small holes at suitable intervals. Before the burner is placed in position under the wheel, the spacer sleeve between the first two wheels is covered with wet asbestos, in order to restrict the transfer of heat to the shaft. The torch is then placed under the first wheel and secured in a level position to insure even heat distribution.

Wheels Must Be Lifted Squarely

By means of a lifting plate and bolts passing through the wheel, the latter is secured to the chain hoist. Care is taken to adjust the bolts so that the wheel will be lifted squarely, in order to avoid binding on the shaft. The burner gas is ignited and adjusted to a low flame. As the heat is absorbed throughout the wheel, a light strain is applied with the hoist, and as soon as the correct temperature has been reached a definite vertical movement of the wheel is noted. The wheel is then rapidly hoisted clear of the shaft. Fig. 2 illustrates the arrangement for this operation.

The procedure is repeated for the successive removal of each wheel, care being taken to cool thoroughly the shaft after each wheel and spacer sleeve has been removed. Cooling may be hastened by the application of an air blast, but cooling of the shaft surface is not sufficient. Unless all the heat is extracted and the shaft restored to its original diameter, difficulty will be experienced in removing the final stage wheels. Each wheel is of course marked so that upon reassembly there will be no question as to location and direction of rotation.

Upon removal of all wheels and spacer sleeves, a careful inspection of the shaft is made. In the case under discussion, corrosion has occurred at each end of the shaft, at the locations of the carbon packing. These areas are repaired by machining, metallizing with stainless steel and regrinding. This procedure not only restores the original dimension, but actually improves the shaft, since the possibility of further corrosion is eliminated.

Metallizing of the shaft is depicted in Fig. 3. Prior to the actual spraying, the shaft is checked for straightness, and any discrepancy corrected. Upon completion of the metallizing, the shaft is re-checked, and straightened if necessary to insure a maximum run-out of .0005-in. Much depends upon the accuracy of this work, as an error of one or two thousandths of an inch materially affects the final balance and the smooth operation of the turbine.

While work on the shaft is in progress, the wheels are being prepared for reblading. Two types of blade construction are encountered in this machine. For the first stage, which carries two rows of blading, the wheel is flanged on each side and the blade shanks pass through radial holes in the flanges, to be riveted or cold headed on the inside. The outer extremity of the blades form rectangular pins, over which are placed sections of shroud band having holes of similar shape.

Each shroud band section is secured to 6 consecutive blades by riveting the pin ends of the latter. In the remaining stages the blade shanks are pressed into holes drilled radially into the periphery of the wheel, and are locked by pins which pass through additional holes parallel to the shaft axis. Each locking pin secures two blades, the drill for the locking-pin hole cutting into the blade shank on each side. The outer ends of these blades also form pin sections for securing the shroud bands.

Gauges Assure Correct Blade Angle

Since it is extremely important that the blades are set at the correct angle, gauges are made for each wheel before the old blades are removed. The rivet heads at each end of the blades are then cut off, locking pins punched out and the blades driven out of the wheels. In performing the latter operation, the blades are carefully supported in order to avoid distortion of the holes in the wheel. After all blades have been removed, the wheel is thoroughly cleaned by sandblasting, using finely screened sand. Excessive blasting at the periphery is avoided, so that the neat fit of the blade shanks in the holes will not be impaired.

The new blades are now pressed into the wheels, using the angle gauges previously mentioned to duplicate the original alignment. For this operation the wheel is placed on a stub mandrel which is mounted on the post of an arbor press. The shroud band sections are then installed and riveted, a forming tool being used to secure neat, uniform heads. The blades of the first stage wheel are riveted inside the wheel flanges, with precautions taken against disturbing the seating of the blade.

The locking-pin holes of the remaining wheels are now re-drilled, cutting a small notch in the blade shanks. In order to avoid enlarging the hole during this operation, the drill is ground to prevent side cutting. Locking-pins are now driven into position and the blading assembly is complete. In the re-blading of the wheel shown in Fig. 4, the usual

UNIT No. 2 CRACKING — CORRECT AS OF _____

No.	SERVICE	TYPE	OPER. ATION.	DATE OPENED															
J-1A	Crude Charge	GAF-3 Stage	C	6-18-40	1-10-43														
J-2	Reduced Crude	" -3 "	C	5-20-40	8-19-42	5-2-44													
J-3	V.B. Fur. Charge	" 4 "	C	6-26-37	4-15-40	11-2-41	5-2-44												
J-3A	" " "	" 4 "	I	1-15-38	11-1-41	2-3-44													
J-4	H.P. " "	GF-9 "	C	1-18-40	11-22-41	7-15-42	5-18-44												
J-4A	AUX. " "	GF-9 "	C	3-20-40	8-19-42	2-27-44													
J-5	H.P. " "	GAF-4 "	C	11-13-39	6-18-40	8-19-42	11-1-43												
J-6	S.R. Gas Reflux	GAT-1 "	C	9-5-40	11-1-43														
J-6A	" " " Spare	GAT-1 "	I	1-20-39	8-1-43														
J-7A	Crude Tur. Reflux	GAT-1 "	I	9-5-40	1-10-43														
J-8A	Spare for J-8 & J-16	YL-1 "	I	2-15-38	4-22-41														
	" " Spare	GAT-1 "		11-13-39	2-15-42														

Fig. 1—Forms used for recording inspection of turbines in the Pan American refinery. Under Operation, "C" indicates continuous, "I" intermittent

procedure has been interrupted to illustrate the various stages of the work. The wheel has been sand-blasted, one-half of the blades have been installed and the mechanic is riveting the shroud band sections.

Each wheel is now mounted upon a suitable arbor and placed in a lathe, where the shroud bands are machined to the design width. Surplus material is provided in replacement shrouds to permit machining the edges to a true surface.

All wheels are now ready for static balancing. This is perhaps the most critical step in the whole job. While balancing is not particularly difficult, the care with which it is performed is definitely reflected in the operation of the turbine. Since this turbine is not equipped with external balancing rings, there is no provision for field correction of shop errors. However, if a high degree of precision is attained in balancing each wheel, and the shaft is straight and true, new machine performance can readily be duplicated.

The wheels are balanced individually by mounting them on a specially designed arbor and using standard balancing ways. These balancing machines are relatively inexpensive and are indispensable to the refinery machine shop. A machine capable of handling work 72 ins. in diameter and of supporting a load of 5000 pounds will prove quite suitable.

Precautions for Best Result

Several precautions are worthy of attention if the best results are to be obtained. The turbine wheel should fit the arbor snugly, and the key-way should be temporarily filled with a key one-half the thickness of the original one. The ends of the arbor which rest upon the balancing way discs should be as small in diameter as practicable, since the sensitivity to unbalance varies inversely as the diameter at these points. The arbor should be accurately ground all over, and it will be found advantageous to harden the ends.

The work must be performed in an area free from draught or air currents which would tend to produce confusing readings. Material is removed from the heavy side of the wheel by grinding, during which operation the arbor and discs should be protected by a suitable covering. The choice of area from which metal is removed depends upon the design of the wheel, and will be discussed later.

The balancing operation is shown in Fig. 5, the covering being removed from the balancing way for clarity. As the work proceeds, location of the heavy side becomes progressively difficult, and it is found helpful to insert a small weight in the blading, noting the effect upon balance for any position around the circumference. When the effect is uniform at any position, satisfactory balance is achieved.

For assembling the rotor, the shaft is again secured in a vertical position on the floor plate. The bore of the first wheel to be assembled and the diameter of the shaft are compared, and a pin-gauge is made, suitable for a slip fit on the shaft. The wheel is secured to the chain hoist and heated with the ring burner until the diameter of the bore is equal to the pin gauge. The wheel is then lowered over the shaft and seated in the correct position against the shaft shoulder. Again the shaft must be thoroughly cooled before proceeding to assemble the next wheel.

Replacement of the reversing buckets follows the same general procedure as wheel blading, and no useful purpose would be served by further discussion of details. The assembling of the rotor in the casing, and the fitting of bearings and carbon packing present no particular problems.

The various designs and materials encountered in different makes of turbines naturally affect repair methods. In addition to the design described above, wheels are sometimes assembled on the shaft with a light press fit and restrained from axial movement by nuts threaded on the shaft at each end. Such wheels are provided with tapped holes for draw bolts. However, if the turbine has been in service for a number of years, permanent distortion of the shaft may result if excessive strain is imposed by the use of bolts and strongbacks. In this event, the wheel should be removed by the method already outlined.

A third design frequently encountered is that in which the wheels are assembled on the shaft with a Class 8 shrink fit. In this design the fit alone is depended upon

Fig. 2—Removing wheels from turbine rotor, which is held in vertical position by bolting coupling to heavy steel plate anchored in floor. Circular gas burner (shown resting on middle wheel) is used to heat and expand wheels, which are assembled to shaft with a light shrink fit. Wheels are lifted off shaft by overhead chain hoist

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to prevent axial movement, and usually there are no spacer sleeves between wheels. This type is the most difficult to dismantle and re-assemble, and several additional precautions are worthy of mention.

Prior to removal of the wheels, accurate measurements must be recorded in order that the wheels may be re-assembled in their correct locations with respect to the thrust bearing and to each other. It is well to make accurately machined spacers to fit between the faces of the wheels, and as each wheel is assembled upon the shaft, it may rest upon the spacers and thus be correctly located and aligned.

For assembling the first wheel, the spacers must be made to rest on any fixed collar or other suitable fitting on the shaft, or if none be available, a temporary collar may be provided. After assembly of the first wheel under such circumstances, it is well to test the face of the wheel in a lathe, since a shrink fit is not a guarantee that the wheel will run true. Upon the accurate positioning of the first wheel depends the accuracy of the remaining ones.

Removal of wheels employing a full shrink fit requires very careful workmanship. The method used is exactly the same as that described for light shrink fits, except that greater expansion of the wheel is required, necessitating higher temperatures. Not infrequently, excessive shrink fits are encountered. A wheel recently removed from a 4-in. diameter shaft was found to have a negative fit of 0.0065 in. Attempts to remove this wheel by ordinary methods failed, and it was necessary to sub-cool the shaft with dry ice and use an acetylene torch in conjunction with the ring burner before the wheel could be persuaded to move.

Under such circumstances, the use of force must be studiously avoided. Forcing the wheel from the shaft before sufficient expansion is obtained will invariably result in severe scoring of the shaft and the wheel bore. Regardless of what measures are necessary, the wheel must be expanded so that a light strain will disturb the fit.

Heat Affects Blades

When turbine wheels are to be removed from the shaft for purposes other than re-blading, due consideration must be given to the effect of heat upon the blading. This is particularly true where nickel bronze blading with high copper content is employed, as over-heating of such material will produce reduction of ductility and strength. From unhappy experience the writer can testify that this condition may produce failure when the turbine is brought up to speed. Overheating is best avoided by covering the wheel blading with wet asbestos or mud. Regardless of the nature of the blading material, the flame of the heating torch should be adjusted so that it does not impinge upon the blades.

Turbine wheels for refinery service are usually carbon steel forgings, and the inserted blading selected from a wide range of alloys. When the blading becomes damaged by corrosion to the extent that replacement is necessary, the wheel itself should be carefully inspected to determine if its condition justifies re-blading. Blade corrosion is accelerated by the erosive action of the steam, and the periphery of the wheel proper seldom escapes damage by the time the useful life of the blading is terminated. The extent of such damage which would be considered permissible would depend largely upon the method used for securing the blading.

In the design previously discussed, corrosion may be severe between the blades, while the metal immediately under them may be unaffected. When the blades are assembled in T-shaped grooves, the surfaces of the latter usually escape damage, but loss of metal from the exposed surfaces should not be ignored. In high speed machines particularly, any doubt of the strength of a wheel should start it rolling in the direction of the junkyard. Scrapping a questionable wheel is far less expensive than a failure which may wreck the turbine.

Removing Metal for Balancing

Wheel design also governs the area from which metal may be removed for balancing purposes. One design provides a "chipping ring" from which metal may be chipped or ground without reducing the design strength. The limit of this area is marked by a small groove machined in the face of the wheel.

Another manufacturer's method is to remove metal from the face of the wheel with a drill. Deep drilling should be avoided, a series of "dimples" being preferable to a single deep hole. In the case of wheels which carry two or more rows of blades, the drilling is sometimes performed at the periphery, between the rows of blades.

Grinding of the wheel face is permissible in some designs, but if considerable unbalance must be corrected, the grinding should not be confined to a small area. Examination of the wheel will invariably reveal the balancing method used by the manufacturer, and this should be strictly followed.

Cleaning Rotors Helps Balancing

Many balancing problems are encountered through uneven corrosion of turbine rotors, by unequal loss of the products of corrosion, and by the deposition of foreign matter. Rotors thus affected may be thoroughly cleaned by blasting the wheels with finely screened sand. Since the blading may be damaged by sand-blasting, fly ash or Portland cement may be used for cleaning the bladed sections.

Single-stage turbines are readily cleaned and re-balanced without removing the wheel from the shaft, using the latter as an arbor for the balancing operation. The dynamic balance of multi-stage turbine rotors is not necessarily disturbed by cleaning, particularly if the operation is confined to removal of deposits from impure steam. However, where corrosion has occurred, and the products of the attack are removed, the balance is generally affected. If the machine is equipped with balancing rings, this defect may be

Fig. 3—Corroded areas on rotor shaft are repaired by machining, followed by metallizing with stainless steel and regrinding. Metallizing, now used extensively in refinery maintenance and repair work, not only restores original dimension, but actually improves the shaft, giving a corrosion-resistant surface

Fig. 4—Riveting shroud bands on a partially rebladed wheel. Prior to installing new blades, wheel is cleaned by sand-blasting; blades are then pressed into position, followed by installation of shroud band sections. Final steps include machining edges of shrouds to a true surface, and balancing

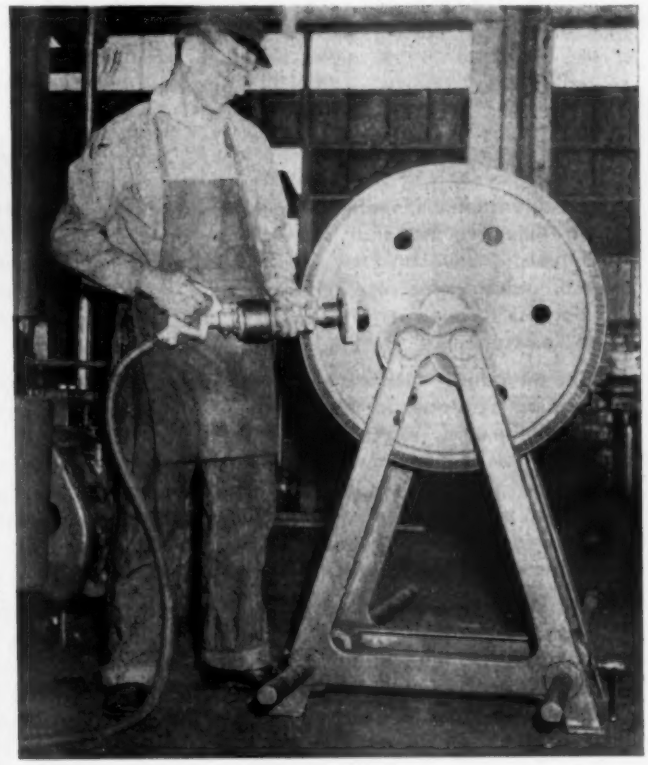

Fig. 5—Balancing a rebladed turbine wheel. New turbine performance can be obtained by paying careful attention to this step and attaining a high degree of precision. Wheels are balanced individually by mounting them on a specially designed arbor and using standard balancing ways

corrected by the installation of balancing weights, but if the turbine is not so equipped, removal of the wheels for individual static balancing may be necessary.

A balancing ring is a collar mounted on the turbine shaft and containing a number of tapped holes into which weights may be screwed to compensate for loss of weight on that side of the rotor. Usually they are located outside and at each end of the casing, so that trial weights may be readily installed or removed. Correction of vibration by this method is frequently a tedious job, requiring a good deal of skill and a large measure of patience. As an expert once described it, "It is a job on which you may work for hours without apparent result, then suddenly the vibration becomes much worse." However, the application of a few elementary principles brings the job within the capacity of any good mechanic.

Prior to attempting to correct vibration by the use of balancing weights, all other possible sources of vibration should be eliminated. Journal and thrust bearings and the carbon packing should be carefully fitted, the shaft checked for straightness, and axial adjustment of the rotor corrected if necessary. The turbine should be free from all piping strains, and any unbalanced parts such as flexible coupling sleeves should be removed from the shaft or secured in a concentric position.

A vibrometer should be available for obtaining readings of the amplitude of vibration at the bearings during each trial run. The first such run will determine at which end of the turbine the trouble is most severe, and the initial trial weight should be installed in the balancing ring at that end. Each hole in the balancing rings should be numbered, and for each run a record should be made of the amount of weight used, its location, and the maximum vibration at each bearing cap.

Locate Centerline of Unbalance

This may be simplified by drawing a series of circles to represent the balancing rings, with numbers to correspond with the numbered holes. For each run, the amount of weight is marked at its location, and the maximum vibration recorded in the circle. Changing the location of the trial weight 90 degrees for the first several runs will quickly establish a series of readings from which the centerline of unbalance may be computed. If this centerline passes through one of the holes in the ring, all that remains is to determine the correct amount of weight required. Usually however, two or even three holes will have to be used, and weights of various lengths will have to be tried in the holes adjacent to the centerline of unbalance. As soon as reasonable balance is achieved at one end, work should proceed at the other end, after which final minor adjustments may be made at either end, according to the readings obtained.

It has been possible in this brief article to outline only in a general way the methods of turbine maintenance and repair which have been developed over a period of years. Local conditions will undoubtedly produce problems not covered by this summary, but these should not prove to be beyond the ingenuity of versatile mechanics. In this work as in most specialized endeavors, experience is the best teacher. The results obtained from the training program at this refinery have fully justified the efforts and the small expense occasioned by minor errors.

The mechanics employed on this work had little if any previous experience in major turbine repairs, but the present condition of the equipment would reflect no discredit upon factory-trained experts. Paradoxically, the greatest compliment they receive is a complaint which is frequently made after they have rebuilt a turbine. The operators have difficulty in ascertaining the speed of the machine with a vibration tachometer.

Technical and Economic Status of Liquid Fuel Production from Non-Petroleum Sources*

(With Recommendations as to a Research Program)

*By Robert E. Wilson***

Co-operation between the government and petroleum technologists in the coming extensive national research to develop non-petroleum sources for liquid fuels is advocated by Dr. Wilson, a prominent scientist and executive of the oil industry. The research project discussed in particular is that authorized by Congress through its enactment of the O'Mahoney law, popularly known as the "oil-from-coal" law.

The oil industry technologists could supply a valuable service by correlating and making available to the Bureau of Mines, the government agency which will administer this research project, a great amount of pertinent data on substitute fuels already in the possession of the oil companies, it is pointed out. Such an advisory committee could also bring to the investigation program the information and experience on processes and operating methods as developed by oil companies in petroleum refining, which might also be applied in the conversion of other raw materials into liquid fuels.

The writer, who also analyzes the proper spheres of industry and government in research programs in general, has a background of experience in governmental, university and industrial research which adds to his qualifications to discuss this problem in the relations of government and industry. He has also consulted in the matter with many governmental and industrial technologists.

Introduction

THE RECENT approval by the Congress and the President of a major research and development program of the Bureau of Mines looking toward the development of alternative sources of liquid fuels, together with numerous other suggestions regarding government co-ordination or regulation of research, makes it particularly timely and pertinent to attempt to analyze the proper functions and cooperative relationships between government and private research in an economy such as ours. Too much of the recent discussions of this problem has been in the fields of theory or of politico-economic controversy in which the writer does not care to participate. It does seem, however, that a serious attempt to analyze a concrete problem such as the production of motor fuel and other liquid fuels from sources other than petroleum, in which the public interest is great, but its reliable information is inadequate, would be of value both to the scientific world and to the public generally.

While the views expressed and the program recommended cannot be attributed to any group, they are believed to be generally in line with the opinions of a majority of technologists in this field, though they will obviously not satisfy the many non-technical extremists, some of whom hold that the government should not do any research, and others that the government should dominate all research.

In discussing the present status of the technologies in the field, the intent is not to give a detailed and quantitative view of the various alternative methods of making liquid fuels, but rather an up-to-date general view of the technologies and economics of the principal processes and the trends which are clearly visible, pointing out in each case the type of additional information which is needed to make further progress in the development of these processes.

Desirability Of a Research Program Even Though A Crude Shortage Does Not Appear Imminent

In discussing in considerable detail the possibilities of making liquid fuel from tar sands, oil shale or coal, the writer does not wish to give the impression that he considers large scale use of these alternatives to be imminent or definitely necessary to "oiling the next war". Recent papers by the author[1] and others[2, 3, 4] present the basic facts of the petroleum supply situation. However, in view of the four outstanding facts that

(a) oil is the prime essential of modern warfare;
(b) discoveries of crude reserves in this country have been slowing down;
(c) foreign sources of crude, however plentiful, might not be readily available in the event of another war; and
(d) known domestic reserves of oil shale and coal both far exceed known domestic reserves of petroleum and natural gas;

it seems obvious that serious attention should be given to developing the technology of various possible methods of making liquid fuels from these latter sources, and also from the tar sands which are so plentiful in central-western Canada. Accordingly, as a minimum safe program, it would appear that at least enough research and development should be focused on each of these three alternative sources to establish more definitely which is likely to be our principal reliance in case a crude shortage should become really imminent, and to demonstrate, on at least a semi-commercial scale, the more promising methods of making liquid fuels from whichever appears to be the most promising source.

Such research and development will doubtless include both laboratory and pilot plant work along numerous alternative lines, and should eventually culminate in "one or more demonstration plants—of the minimum size, which will allow the government to furnish industry the necessary cost and engineering data for the development of a synthetic liquid fuel industry" as provided in Public Law 290. Contrary to widespread impression, neither the Act, nor the Bureau of Mines' technologists, contemplate the building of large standby plants, commercial operation of a plant of any size, or the premature construction of even demonstration units as above defined until much more laboratory and pilot plant research is carried out, supplemented, if possible, by additional information from foreign sources.

However, such a government-financed program will probably not constitute the principal source of new technology in this field. For example, long before the above-mentioned p r o b a b l e ultimate sources of liquid fuels become of commercial importance, there are many "intermediate" technologies, such as the hydrogenation of petroleum fractions, the conversion of natural gas into gasoline, and other processes which will come into the picture in a substantial way. To illustrate how such technical developments are worked out naturally in a free economy, the two above-mentioned "intermediate" technologies likely to come into commercial use within the next few years are closely related to the most promising processes for converting coal into oil.

The development and increasing use by industry of these "intermediate" processes, which is certain to come long before there is any need to go to the conversion of coal, will lead to a great accumulation of new information applicable to coal conversion operations which would be impossible to achieve in the research laboratory alone, or even in a few "dem-

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*From *Chemical & Engineering News*, Aug. 10, 1944.

**President, Pan American Petroleum & Transport Co.

onstration units" built according to present knowledge. The same general situation exists with regard to catalytic refining processes in general, whose development and use by the petroleum industry is still in its early stages, with important advances already in progress in many different fields, several of which will be useful in making better quality products from coal or shale. Also, much of the new refining equipment will be of great value in handling the crude products obtained from shale or coal.

This natural and competitive development of substitute processes, plus information from abroad, has already shown us how to make unlimited quantities of gasoline from coal at prices lower than those prevailing after the last war and, if allowed to continue the natural course, will almost certainly reduce the costs of gasoline made from coal or the richer oil shales to a figure **not over 5 cents per gallon above present gasoline costs from crude petroleum.** In the light of these facts, there is certainly less need for concern as to the future of our liquid fuel supplies than there was after the last war, when pessimistic estimates of crude reserves caused widespread concern, and we did not even dream of the possibility of making gasoline from coal, at any price.

If crude prices should show a gradual up-trend after the war, industrial research on substitute sources for fuel would be greatly stimulated and could be relied upon to "carry the ball" with little or no government assistance. On the other hand, if increased importation of relatively cheap foreign crudes kept domestic crude prices low, industry research on substitute sources would tend to lag and a government-supported program would be more necessary, even though it could not fully offset the reduced rate of development work by the industry. Technical developments in this field, particularly in connection with handling solid materials on a large scale, do take time and money, and, from the view-point of broad national interest, it would be foolhardy not to get started on a substantial program well in advance of any certainty as to the need therefor.

"Intermediate" Processes For The Production Of Liquid Fuels, Prior To The Utilization Of Shale Or Coal

Conversion of Petroleum Residues Into Higher Grade Fuels

In considering substitute sources of liquid fuels, the primary concern should be to meet those liquid fuel requirements for which the user can afford to pay a premium over the price of coal on a heat content basis. In the past, much of our heavier petroleum residues have been burned by large power plants in competition with coal on essentially a B.T.U. per dollar basis. One of the first things to occur, if and when the petroleum supply situation tightens, will be the installation of equipment to convert these heavier residues into the lighter and more valuable liquid fuels (including gasoline).

The large-scale installation of catalytic cracking units in this country in connection with the 100-octane aviation gasoline program is an indirect step in this direction, since the catalytic cracking process produces more gasoline and light fuel oil, and much less residual fuel oil, than does thermal cracking. In addition to catalytic cracking, the technology of directly converting petroleum residues (or catalytically cracked light fuel oils) almost entirely into gasoline by hydrogenation has been throughly developed, and its general use by industry would increase rapidly if the present differential between the price of crude and that of residual fuel oil should increase by about one cent per gallon.

In other words, the advent of catalytic cracking, and the availability of hydrogenation, is taking residual fuel oils out of the class of unavoidable byproducts, and giving them a definite and substantial value as a crude substitute. The tendency will accordingly be for the price of such fuels to keep within less than 2c per gallon of the price of crude in a given area and, if and when the crude price rises, they will gradually pass out of uses where they are in direct price competition with coal. The process will be gradual, first, because of the time required to build hydrogenation plants and, second, because of the effect that higher crude prices would have on increased discovery rates and increased importation, both of which will tend to prevent any very rapid increase in the price of crude.

Conversion of Natural Gas to Liquid Fuels

The most immediately promising source of liquid fuels, other than crude oil, is natural gas. The most promising method for the conversion of gaseous to liquid fuel is based on the Fischer synthesis, whereby a mixture of carbon monoxide and hydrogen (as in water gas made from coke and steam) are converted by catalysis at moderate pressures and temperatures into a series of hydrocarbons similar to those in petroleum. To this basic process have been added processes for making the carbon-monoxide-hydrogen mixture catalytically from steam and natural gas.

Pilot plant work on both these steps is being actively carried on by several different industry laboratories. It is already evident that the pre-war European technology can be greatly improved upon, and it seems probable that gasoline can be made from cheap natural gas in the more remote fields at costs similar to present costs of making gasoline from crude. While the gasoline tends to be rather low in octane number, modern catalytic refining processes will make it quite acceptable. The process will also yield high quality Diesel fuel and wax.

While the conversion of natural gas by the Fischer process, like the hydrogenation of heavy petroleum residues, is important from the standpoint of augmenting our raw materials for liquid fuel manufacture at costs not far from present costs, it cannot be considered an ultimate solution of the problem. The total known domestic reserves of natural gas on heat content basis are not quite as large as those of crude petroleum. Also, many of the larger reserves are already earmarked for public utilities, and the efficiency of conversion to liquid fuels is not as great as in the case of crude.

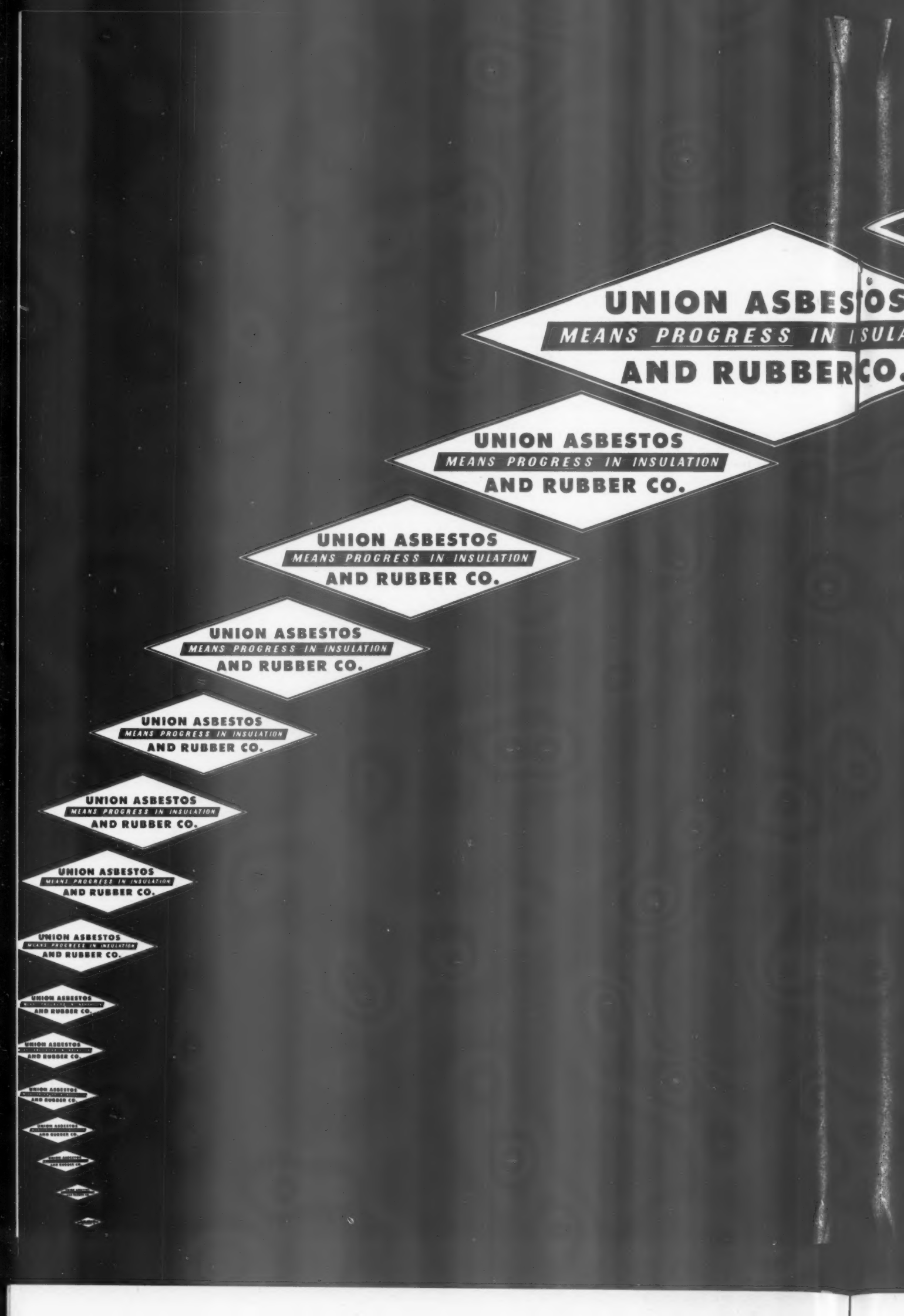
Presently attainable gasoline yields from methane (allowing for fuel used in the process) are around 50% on a B.T.U. basis, as compared with around 85% from crude by catalytic cracking plus hydrogenation. On the other hand, the trend in recent years has been to find more gas per barrel of oil discovered, and this ratio will probably continue to increase as improvements in drilling technique permit the exploration of deeper and deeper sands. In the light of present knowledge, however, it does not appear that the over-all recovery of liquid fuels from *presently known* natural gas reserves will exceed a few billion barrels. Thus, this process, using present and future gas reserves, will serve more to help "stretch" our crude reserves over an extra decade or so than to take their place.

Other Possible "Intermediate" Technologies

During the period (of uncertain length, possibly several decades) between the beginning of some commercial use of the foregoing processes and the next major step of substantial utilization of oil shale and/or coal for the production of liquid fuel, there will be an interesting race among various competitive processes. It seems probable that under local conditions of unusual supply or demand or large transportation differentials, numerous processes may come into local use long before they are commercially feasible on a nationwide scale.

Consider, for example, the single problem of the supply of household fuel, for which the customer is glad to pay some premium to avoid the use of coal. The original type of home heating fuel, namely, light gas oil distilled from crude, will presumably have been very largely diverted to Diesel fuel or charging stock for cracking, but among the known possibilities which will be competing for this major market will be

1. Distillate heating oil made as a by-product from catalytic or thermal cracking
2. Imported heating oil
3. Natural gas from distant points
4. Artificial gas made from coal in local plants
5. Artificial gas made from coal gasi-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fied at the mine mouth and transported by pipeline.

To show some of the complicated interrelationships between these alternatives, consider the following examples:

Heating oil from catalytic or thermal cracking can fairly readily (by hydrogenation, plus catalytic cracking) be converted to the extent of around 80% into gasoline. The value of such oils will accordingly tend to approach (but not equal) the value of gasoline when and if crude becomes short and hydrogenation facilities are generally available. This will make it easier for natural or artificial gas to compete in areas which they can economically reach. On the other hand, the availability of processes for the conversion of natural gas into gasoline will tend to increase its value at the well, even in remote areas, and thus tend to make it less competitive for household fuel, though the cost at the well is not a large factor in Eastern markets.

At the same time, higher gasoline and fuel oil prices will tend to increase the value of benzol and other by-products obtained in making artificial gas from coal and hence reduce the net cost of artificial gas, though the oil required to enrich coal-and water-gas up to meet present B.T.U. standards will become more expensive. The use of natural gas to enrich coal-and water-gas may well increase and become an important factor in conserving oil.

In this group of "intermediate" competitive processes, transportation costs are a particularly important factor. Some interesting points in this connection are:

1. The 24-in. pipeline will transport about 9 times as many B.T.U. per day in the form of crude or heating oil as in the form of natural gas. Thus gas transportation by pipeline can compete with oil transportation by the same means only when the price of gas in the field is much lower per B.T.U. and/or the price of gas at the point of consumption is much higher per B.T.U. than that of oil. (Historically, both conditions have generally prevailed, and will probably continue to do so, but with narrowing margins of difference.) On the other hand, tankers are competitive with even the largest pipelines for the transportation of liquids, so gas transportation might be the logical postwar use for the large War Emergency Lines.

2. The pipeline transportation of unenriched gas from the complete gasification of coal costs around 4 times as much per B.T.U. as does that of natural gas on account of the low heat content per cubic foot of the former. If oil for enrichment is as cheap or cheaper near the point of consumption as at the mine mouth, it is generally cheaper to ship coal by rail than to pipe unenriched gas for any considerable distance. Availability of natural gas near the mines for enrichment purposes might change this picture.

3. Pipeline transportation costs for either oil or gas increase rapidly as the load-factor decreases. Since the heating load has a large seasonal fluctuation, transportation and storage of liquid or solid fuel has a substantial advantage for any volume above that assured as a fairly steady, year-round load.

4. From the Southwest to most New England points, ocean transportation of oil is far cheaper per B.T.U. than any other method in sight for the transportation of fuel.

As the result of the interworking of these and other factors, it would appear that under a reasonably possible future set of conditions, the most economical household fuel (other than coal) for points in Western Pennsylvania, would be artificial gas, while a natural gas line passing through Western Pennsylvania (and not competitive in that area) would (on account of lower transportation costs) be the cheapest source of household fuel in Eastern Pennsylvania, and at the same time furnace oil (made either from crude or from natural gas in Texas) shipped by tanker, would be the cheapest source of household fuel in New England.

Agricultural Sources

There is some technical literature and considerable propaganda to indicate that the fermentation of agricultural wastes or other products to make alcohol would be an important source of motor fuel, at costs lower than those for oil shale or coal. However with the possible exception of a few points where an unusually favorable waste material may have had its gathering costs already paid by some other main product, the cost of making alcohol from such sources is far above its value for motor fuel, taking into account the fact that a pound of alcohol has only two-thirds the heating value of a pound of the usual hydrocarbon fuels.

Alcohol does have the advantage of a good blending octane value, but it is relatively insoluble in ordinary motor fuel and the more dilute blends have a tendency to separate into two phases under ordinary storage conditions in the presence of water or high humidity.

It must also be kept in mind that the demand for industrial alcohol in synthetic organic chemistry is continually increasing, and that any alcohol made from available agricultural wastes at costs permitting its use in motor fuel would be worth more for other purposes. Also, the total volume obtainable from collected agricultural wastes in question is very small in comparison with the volume of motor fuels required. To make alcohol from starch or grain or other food products would, of course, put it into a still higher cost bracket and hence alcohol from such sources is an even more remote possibility as a substitute fuel.

Recent reports of converting waste agricultural products by destructive distillation into petroleum-like materials have not been supported by adequate data to permit reaching any conclusion as to probable costs or yields.

The Manufacture Of Liquid Fuels From Oil Shales, Tar Sands And Coal

The probable ultimate source of raw materials for liquid fuel manufacture lies in those solid substances which will have to be mined, such as oil shales, tar sands, and coal. The sum total reserves of bituminous matter contained in these substances is tremendous, and they could supply our probable needs of liquid fuels for more than a thousand years.

It is difficult to be certain from presently available information which substance will come into predominant use first. However, the important fact is that, at the present state of process development, all of them will, under favorable conditions, give gasoline at costs not over 10 cents above present prices, and none of them can as yet be relied upon to make it for less than 5 cents above present prices. Mining costs will constitute a substantial part of the total cost, particularly in the case of oil shale, and probably geographical consideration will be a large factor. Also, the deposits of oil shale and tar sands vary a great deal in richness, so that the richest deposit of such might well come in ahead of coal, whereas the poorer deposits might never be called upon.

In view of the uncertainty above mentioned, the following discussions are presented without any implication as to the probable order in which the respective resources will be developed.

Old Shales

The wide variety of figures in literature as to the cost of making gasoline and other petroleum products from oil shale largely reflect major differences in the assumed figures as to the richness of the deposits, and the costs of mining and of shale disposal, which are the principal factors in the cost of making liquid fuels from oil shale. The importance of mining costs increases rapidly as the richness of the shale decreases. Accordingly, one of the most important things to be studied in order to determine more accurately just how soon, and to what extent, oil shale can be used as a source of substitute liquid fuels, is to conduct some really thorough exploration of our oil shale reserves with determinations of the oil content throughout the body of the better deposits, rather than that of the mere outcroppings.

Where major deposits of good quality material are located consideration should also be given to the important problems of available space for cheaply disposing of the shale residues, adequate water supply, rail facilities, etc. Once the most promising major deposits are located and blocked out, an imaginative investigation should be undertaken in an effort to develop better mining methods in the hope of reducing this very large element of

cost and, in any case, establishing it more definitely than it has been to date. Government agencies are particularly well adapted to carrying out such investigations, and if they do not do it, it is not likely to be done in the reasonably near future.

While the reserves of oil shale in this country are very large, it should be emphasized that only a small proportion of the presently known reserves appear to possess the desirable characteristics necessary to permit their commercial use on a basis competitive with coal. While very little research or development has been carried out on shale oil during the last 15 years on account of the general feeling in the industry that the prospect of using it is rather remote, it is known that hydrogenation will greatly improve the quality of the product. It is probable that after moderate development work gasoline could be made from some of the richest shales for around 5 cents per gallon above present prices.

Tar Sands

There has been a great deal of interest in the very large reserves of tar sands along the Athabasca River in West Central Canada. However, the situation with regard to these sands is similar to that with regard to oil shales in that the deposits differ greatly in their oil content and in the ease of mining. Except for factors of geography, the richer tar sands appear to be a somewhat more economical source of the heavier hydrocarbons than the richer oil shales, but the remote location of the principal tar sands may well outweigh this advantage. In any case, the amount of tar sands definitely known to be rich, and which can be cheaply mined, is small compared to the figures generally quoted as representing the total reserves.

Again the importance of a more thorough exploration of the location and quality of the reserves, and the study of commercial mining or displacement methods, would seem to be desirable in order to permit a better evaluation of the real magnitude and relative promise of this possible source of liquid fuel, particularly the heavier fuel oils.

Coal

The one substitute source of liquid fuel about which there can be no doubt as to either the quality and quantity of the reserves, is coal. In this case, mining costs are less important because the oil yields per ton are substantially higher, and coal mining costs, under different conditions, are already fairly well established. The major problems in this field are in connection with working out the best combination of processes for converting the coal into liquid fuels. Presently known processing methods are undoubtedly capable of marked improvement.

There are two general methods by which coal can be converted into liquid fuels. The first process to be developed, known as the hydrogenation process, involved treating powdered coal in an oil slurry with hydrogen under high pressure, in the presence of catalysts, to make a heavy liquid which can be further hydrogenated under still higher pressures to make gasoline and other products. This process, and the related process for the hydrogenation of coal tar, have been the principal reliance of the Germans for the production of aviation gasoline during the war. Very large investments and steel tonnage are required and, in its present state of development, the process is believed to be considerably more expensive than the alternative Fischer synthesis for the production of gasoline. The hydrogenation process does, however, have the advantage of giving somewhat better quality gasoline, and it can also be adapted to producing heavy fuel oil by carrying the process only part way, and under more moderate pressures.

A more recent process, also developed and widely used in Germany, is the Fischer process previously referred to, whereby carbon monoxide and hydrogen (water gas) made from coke and steam are converted into gasoline and other petroleum products. Only a few years ago this process was considered definitely inferior to hydrogenation because of the relatively high cost of the coke with which the process started, and the poor quality of the gasoline produced.

Within recent years both these objections have been overcome. In the first place, catalytic refining methods have made it possible to produce high quality gasoline from the Fischer product. In the second place, it has been found that it is not necessary to start with high grade coke made from relatively scarce coking coals, but that the necessary mixture of carbon monoxide and hydrogen can be made advantageously from the many large deposits of sub-bituminous coal and lignite, for which there is relatively little other demand. The high water content of lignite makes it somewhat less attractive than sub-bituminous coal, except where mining costs are very low, but large deposits of both materials are available for economical strip-mining in various parts of the country.

Starting with these materials, there are a variety of low-temperature carbonization processes or continuous gasification processes, from which it is possible to make the necessary synthesis gases at moderate costs. Some of these processes bring into play the above-mentioned types of intermediate processes for converting gaseous hydrocarbons into carbon monoxide and hydrogen. The by-product liquids produced by the cheaper low temperature carbonization processes have always been hard to market in the past, but there is evidence that hydrogenation, alone or combined with other processes, will overcome these difficulties as well.

In the light of these developments, the technical and commercial possibilities of the Fischer Tropsch processes, particularly as applied to low grade coals, have advanced very rapidly in the past few years, quite apart from developments which have doubtless occurred in Germany. While to determine the best combination of steps for converting a given type of coal into gasoline will require much more research and pilot plant testing, it is the opinion of the best informed technologists that the Fischer process, probably starting from sub-bituminous coal, is now the most promising major source of liquid fuel for the long-range future. While the investment required will probably be three or four times that required in refining petroleum, and the ratio of labor required something like double, it appears that, given a few more years of research and development, gasoline can be made from coal by one of the above mentioned combination processes for not over 5 cents per gallon above present costs from crude petroleum.

Some of the above combination processes have the further advantage of producing large quantities of ammonia, benzol, phenol and other by-products. The type of process ultimately used may depend considerably on the extent of the demand for these by-products and for by-product gas.

Recommendations Regarding Government Research On Substitute Sources Of Liquid Fuel

While some in the petroleum industry have been critical of the proposed government financing of large scale demonstration units for making liquid fuel from coal or oil shale, much of this criticism has been based on the mistaken assumption that it was planned to build large plants prematurely based on presently known technology. The industry has seen too much of the value of research to oppose any well planned program by any agency which will add to the sum total of useful knowledge relative to the industry. There are, however, certain basic characteristics of, and problems connected with, all tax-supported research, which indicates the desirability of close examination and proper guidance of any government research program.

Tax-supported research has the following general advantages and disadvantages:

1. On account of the absence of the profit motive, it is possible to study certain types of problems of general national interest which no private concern would feel justified in undertaking. Problems involved in meeting possible future wartime shortages or other contingencies of many sorts are cases in point.

2. On the other hand, this same absence of the profit motive, plus the comfortable permanence of the employment and the proper interest of the personnel in any subject under study, makes it very difficult to terminate or re-direct lines of research even after they have lost any real promise of practical value.

3. Unless there is a definite mechanism

set up and regularly used to keep the research in close contact with practical developments in a given field, work is likely to be continued long after a given problem has ceased to be of importance because of new developments within an industry.

4. Research by governmental agencies is always likely to be subject to political pressure to direct it into one channel or another favored by some particular group, rather than being determined entirely by sound technical considerations.

5. In addition to the unfairness of taxing business in order to compete with it, government research in fields of immediate industrial importance is likely to defeat its own ends by discouraging a much larger volume of research which would otherwise be undertaken by private industry. Also, if the government undertakes research in a highly competitive field, it is naturally difficult to secure the needed industry cooperation and advice.

6. In the relatively few cases of really important commercial discoveries by government laboratories, it is frequently difficult to bring about prompt commercial use. First, because there is no pride of discovery to cause any one company to push the development along and, second, because, in the absence of a patent or an exclusive license, there is little incentive for a company to assume the heavy expense of development and marketing a new product because if it is successful it will quickly be copied by others who have avoided the initial expense and hazard.

7. Government research is particularly well adapted to fields like agriculture and forestry, where the overall public interest is large, and yet no appropriate private concerns exist to carry out more than a small fraction of the needed research.

8. Government research is also peculiarly adapted to making surveys of available raw material resources and methods of recovering same, especially where they are on the public domain.

9. The government is again the appropriate agency for much of the research in standardization and testing methods, where it is important to have an impartial arbiter between different producers, or between producers and consumers.

10. Government agencies may also well undertake fundamental research into the basic reactions and characteristics of our raw materials, which is of value to industry generally, but which no individual company is likely to undertake on a broad scale. An excellent example is the careful study by the Bureau of Standards, largely financed and guided by industry, of the composition of the individual hydrocarbons present in petroleum. This work proved to have unexpectedly prompt and large value in connection with the 100-octane program.

11. Government financing of research in University and Foundation laboratories would have many advantages in making possible effectual employment of the time and abilities of large groups of professors and advanced students completing their training. The little publicized, but enormously valuable work of the National Defense Research Council during this war is illustrative of the possibilities. One difficulty during peacetime, would be to have the work directed by a sufficiently eminent and non-political group of scientists to resist the many pressures to assign the financial support on some basis other than the ability and facilities of the respective institutions, a large number of which would desire such funds to supplement their educational budgets.

In the light of these general considerations re government research, and the status of the substitute fuel outlook previously discussed, the logical first objectives of government research in these fields would appear to be as follows:

1. In the field of oil shale, the information most needed to permit accurate appraisal of its commercial possibilities is, first, better information regarding the size, location and *average* oil content of the more promising shale deposits, and, second, better information as to the cost of mining such deposits, using modern machine methods. The government should undertake investigation along both of these lines, including some full scale tests on the use of modern mining machinery in representative types of deposits.

Any extensive effort to develop improved retorting methods, should probably await preliminary determination of whether oil shale can reasonably compete with the coal processes, as a substitute source of liquid fuel, but some pilot plant retorting would probably have to be carried out in order to reach this preliminary conclusion. The industry will gladly cooperate in determining the applicability of modern methods of hydrogenation and catalytic cracking to the crude shale oil obtained in such investigations.

2. In the field of coal utilization, mining costs are better established and are of less importance in determining final costs. Much research and pilot plant testing needs to be carried on in various combinations of the available processes as applied to different types of coal, particularly sub-bituminous coals and lignites. There should be particular emphasis on the development of better methods for the continuous gasification of low grade coals to make Fischer Synthesis gas.

An effort should be made as soon as the European war is over to learn the latest developments of German technology as the result of their intensive practical experience, and compare these developments with those which have been made in this country. Not until this information is available and studied should there be construction of commercial size demonstration plants which would be obsolete before they could be completed.

3. In this connection, it should be emphasized that, while there are many processes which cannot be readily demonstrated on a laboratory scale, recent developments in the design and operation of pilot plants, and the interpretation of pilot plant results, makes it possible to get, at moderate cost and on a small scale, results which can be applied with accuracy to commercial size units. Such small pilot plants are not only far cheaper to build, but they permit operation under a wide variety of conditions and charging stocks, and give many times as much information per dollar expended in their operation as it is possible to get from commercial size units.

4. As to research on tar sands, the known sands within the U. S. are relatively unimportant, though some work should probably be undertaken to determine more definitely their size and quality. However, the really large deposits are in Canada and it is hoped that the Canadian government, possibly with the advice and help of the American government, will continue and expand their research on the mining and utilization of these deposits to determine whether or not they will come into the picture ahead of oil shale or coal, or behind them.

5. If the Navy is authorized to make their requested study of the production of Navy fuel from oil shale, the technical investigations should preferably be carried out by the Bureau of Mines as a part of the above-described program.

6. One major line of investigation which will be costly and time-consuming, but which should not be overlooked in view of its possible major importance, is that of gasification, distillation or extraction, in the ground, of the solid bituminous materials above discussed. Radically new techniques would have to be developed, but the magnitude of the savings, particularly of labor, by avoiding mining operations, are great enough to justify a comprehensive and imaginative study of the possibilities, particularly of the controlled gasification of coal in the ground to make Fischer synthesis gas.

If the Bureau of Mines is in general accord with the principles and the program above outlined, the writer is of the opinion that the petroleum industry would be willing, if the government so requested, to set up an advisory committee of technologists, well versed in these fields, to bring together and analyze existing data from various sources. On the basis of this correlation of information, they could advise and co-operate in recommending detailed research programs, designing pilot plants, and keeping the investigations guided along the most useful and practical lines.

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[1]Technology As a Multiplier of Our Natural Resources, *Chem. and Eng. News*, Pg. 784.

[2]J. Edgar Pew, "Pew Counters Pessimists", NATIONAL PETROLEUM NEWS, 2/23/40, Pg. 6.

[3]Eugene Holman, NATIONAL PETROLEUM NEWS, 4/26/44, Pg. 40.

[4]Wallace Pratt, "Undiscovered Resources Equal to Those Already Found Held Probable," *Oil & Gas Journal*, 12/30/43, Pg. 78.

Economic Design of Pressure Vessels

(Article 4—Analysis of External Pressure Vessels)

By E. F. Brummerstedt*

The cost of external pressure vessels involves two items—the shell of the vessel, and the stiffening rings. Cost for the shell of a vessel of any given size depends upon the wall thickness, and the wall thickness in turn determines the number of stiffening rings required.

Mr. Brummerstedt's article this month develops methods for determining the optimum thickness which will allow the most economical spacing of stiffeners, thus resulting in the lowest total cost. After developing suitable equations, an actual example is worked out.

THE DISCUSSIONS PRESENTED thus far in this series have not included vessels subjected to external pressures. Previous to this year, all such vessels were designed in accordance with the A.S.M.E. Code, Sect. VIII, but the 1943 edition of the A.P.I.-A.S.M.E. Code (Sect. EW) includes provisions for external pressure design, which will be adhered to in this analysis.

The wall thickness of a vessel subjected to external pressure depends on the ratio of length between stiffening rings to external diameter, per Figs. 27 and 28 of the Code, as well as on the external pressure. With the exception of jacketed vessels, which require special consideration, external pressures are ordinarily limited to 15 psi for high vacuum service, and that pressure will be the basis of this analysis.

With the pressure constant, the remaining variable determining the thickness is the length-diameter ratio, which for a given diameter leaves the length as the only variable. Hence for a cylindrical vessel of specified diameter and overall length, the thickness is directly proportional to the length between stiffening rings or head tangents. The obvious problem then arising is the determination of the most economical spacing of stiffeners, the solution of which will be explained in this discussion.

Cost of Shell

The total cost in dollars of the cylindrical shell was given in a previous analysis (*NPN Technical Section, May 3, 1944, pp. R-282-283*) as

$$C_1 = W_1\left(\frac{X_1}{100}\right) \quad \ldots\ldots (1)$$

where C_1 = total cost of shell in dollars,
W_1 = adjusted weight of shell in lbs,
X_1 = cost of shell in cents/lb.

In the same article, the adjusted weight of the shell was given as

$$W_1 = twD(\pi L + 3.48D) \quad \ldots\ldots (2)$$

and the unit cost of the shell as

$$X_1 = K - 1.75t \quad \ldots\ldots (3)$$

where t = thickness of tank shell in inches,
w = weight of steel in pounds/unit volume,
D = diameter of tank in feet,
L = overall length of tank in feet,
K = basic cost constant per pound, based on shop labor rates and standards.

Substituting Equations 2 and 3 in Equation 1

$$C_1 = twD(\pi L + 3.48D)\left(\frac{K - 1.75t}{100}\right) \quad \ldots\ldots (4)$$

In this analysis K is 8, based on shop cost analysis; and w is 42.8, the weight of 1 in. plate (including 5% overweight tolerance) in lbs/sq ft.

Substituting these values in Equation 4 and simplifying,

$$C_1 = 42.8tD(\pi L + 3.48D)\left(\frac{8 - 1.75t}{100}\right)$$
$$= 10.75tD(L + 1.11D) - .219tL - .242tD) \quad \ldots\ldots (5)$$

and, assuming a given L and D, we have the thickness t as the only variable.

Cost of Stiffeners

The cost of the stiffeners is the other factor determining economical design of a vacuum vessel. Structural steel shapes are costlier per pound than plate, and with the labor of rolling them and welding them to the shell their costs, based on many examples analyzed and plotted, vary according to the expression

$$X_2 = K - .30w_1 \quad \ldots\ldots (6)$$

where X_2 = cost of stiffeners in cents/lb,
K = shop cost constant, based on labor rates and shop standards (K=30 in Foster Wheeler Carteret shop),
w_1 = weight of stiffener in lb/lineal foot of length.

The total cost in dollars of the stiffeners for a given tank can be expressed as

$$C_2 = \frac{n\pi D w_1 X_2}{100} \quad \ldots\ldots (7)$$

where C_2 = total cost of stiffeners in dollars,
n = numbers of stiffeners,
D = diameter of tank in ft.

*Petroleum Refinery Division, Foster Wheeler Corp., New York.

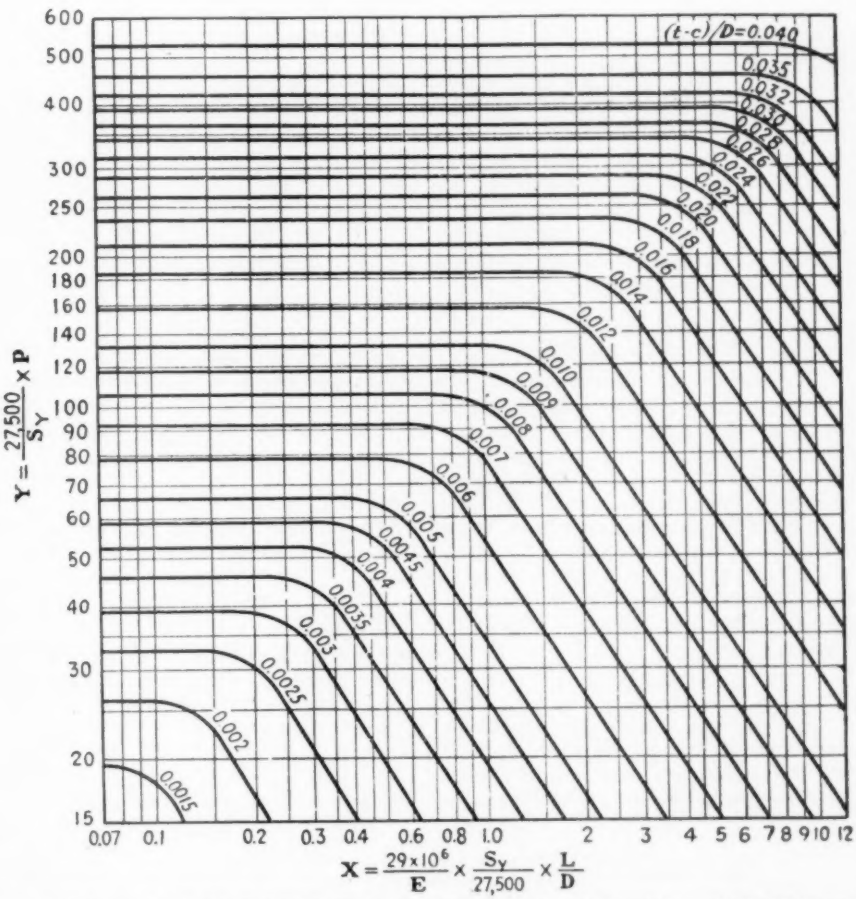


Fig. 27 from the A.P.I.-A.S.M.E. Code (p. 86)—chart for determining shell thickness of unfired cylindrical vessels of mild carbon steel subjected to external pressure and having an L/D ratio equal to or smaller than 12

TABLE 1—Comparison of Calculated Costs for External Pressure Vessel (10 by 50 ft.) Using Varying Wall Thicknesses

t (in.)	D_o (in.)	t/D_o	L_1/D_o	L_1 (in.)	I_s (in.^{4})	Stiffener Channel (in.)	w_1 (lb/ft)	n	C ($)
¼	120.5	.00208	.24	29	3.55	4	5.4	20	2515
5/16	120.625	.00259	.82	50	6.35	5	6.7	11	2600
⅜	120.75	.00311	.65	78	9.9	6	8.2	7	2750
7/16	120.875	.0036	.95	114	14.5	7	9.8	5	3000
½	121	.00414	1.35	163	20.7	7	9.8	3	3140

Substituting Equation 6 for the X_2 value in Equation 7,

$$C_2=\frac{n\pi Dw_1(K-.30w_1)}{100}$$

and since $K=30$,

$$C_2=.942nDw_1(1-.01w_1) \quad \ldots\ldots (8)$$

The total cost of the vessel, including the shell and stiffeners, can then be expressed by combining Equations 5 and 8 as

$$C=C_1+C_2$$
$$=10.75tD(L+1.11D-.219tL-.242tD)+.942nDw_1(1-.01w_1) \quad \ldots\ldots (9)$$

Since t, n, and w_1 are all variable unknowns, this equation cannot be differentiated to find the minimum cost combination. The obvious solution is by trial and error. In order to keep the trials to a minimum, it is best to first assume the minimum practical value of t, solving for n per Fig. 27 (or Fig. 28 in unusual cases) and w_1 per paragraph EW-309.1 of the A.P.I.-A.S.M.E. Code.

In assuming the minimum practical thickness, consideration must be given to the factors of elastic and structural stability, and ability to withstand an internal pressure of at least 25 psi, since that is the equivalent internal pressure for 15 psi external pressure, as far as the heads are concerned. (Par. EW-310.)

Example of Computation

To illustrate how these equations just developed can be applied, let us assume that we are designing a tank which is to be 50 ft long by 10 ft internal diameter, subjected to 15 psi external pressure at a temperature of 100°F. We want to determine the most economical thickness and stiffener spacing.

To start off our trial and error solution, assume a minimum thickness of ¼ in., with no corrosion allowance. Hence

$$t=t-c=.25$$

Since our tank is to be 10 ft. in diameter, then D_o, the outside diameter, will be 10 ft. plus twice our assumed wall thickness, or 120.5 in. And in Fig. 27

$$\frac{t-c}{D_o}=\frac{.25}{120.5}=.00208$$

Interpolating this value in Fig. 27, then, the value of the X coordinate is 0.24 for a value of 15 of the Y coordinate. At a temperature of 100°F, the E and S_y terms in the equations for the X and Y coordinates are equal to unity and hence cancel out, which leaves

$$X=L_1/D_o$$

and

$$Y=p \text{ (given as 15)}$$

Solving for L_1,

$$L_1=D_oX=120.5\times.24$$
$$=29 \text{ in. or } 2.42 \text{ ft.}$$

where L_1 = length between stiffening rings, in inches to be differentiated from L, the overall length of the vessel.

To find the number of stiffeners required, then.

$$n=(L/L_1)-1$$
$$=(50/2.42)-1$$
$$=20$$

From paragraph 309.1 of the Code

$$I_s=\frac{.14D_o^3pL_1}{E} \quad \ldots\ldots (10)$$

where I_s = required moment of inertia of the stiffening ring attached to the shell about the centroidal axis parallel to the axis of the vessel, in inches^4,

D_o = outside diameter of shell, in inches,

p = maximum allowable external working pressure, in psi,

L_1 = length of vessel between head bend lines or between centers of circumferential stiffeners, measured parallel to the axis of the vessel, in inches,

E = the modulus of elasticity of the material in the stiffener at the design operating temperature, in psi.

We know the values for outside diameter, external pressure, and length between stiffeners. The value for the modulus of elasticity E can be taken from Fig. 26 of the code as 29×10^6 at 100°F.

Substituting in Equation 10,

$$I_s=\frac{.14\times120.5^3\times15\times28}{29\times10^6}$$
$$=3.55 \text{ in.}^4$$

From any structural steel handbook, the lightest structural shape having this moment of inertia is a 4 in. channel, 5.4 lbs per lineal foot of length. Hence w_1 (Equation 6) equals 5.4 lbs/lineal foot.

Substituting in Equation 9 for the total cost,

$$C=10.75\times.25\times10(50+1.11\times10-.219\times.25\times50-.242\times.25\times10)+.942\times20\times10\times5.4\times(1-.01\times5.4)$$
$$=26.9(57.76)+1020(.946)$$
$$=1550+965$$
$$=2515 \text{ dollars}$$

To continue the trial and error solution, repeat the above steps, increasing the value for the thickness by 1/16 in. with each successive trial. Additional results for the example just worked out have been calculated in this manner and are tabulated in Table 1.

From this table it appears that the thinnest plate is usually the most economical. However, by adding 1/16 in. to the minimum thickness the number of stiffeners can be cut almost in half, giving a more practical design without adding appreciably to the cost.

If an external pressure greater than 15 psi is specified, it is usually possible to read the lowest possible t/D_o ratio directly from Fig. 27, and also the corresponding maximum L_1/D_o ratio below the point where the horizontal t/D_o line begins to curve downward. That combination is usually the most economical, although several additional trials may be made as explained above.

These formulae are based on net thicknesses and weights, without corrosion allowance. The usual ⅛ in. corrosion allowance can easily be added to the thickness and a proportionately higher cost calculated without changing the method of economical design.

It is assumed that all stiffeners would be attached externally, and hence require no corrosion allowance. For fractionating towers where they are attached internally and also serve as bubble tray supports, the problem of economical stiffener spacing does not exist, since that is usually determined by the tray spacing.

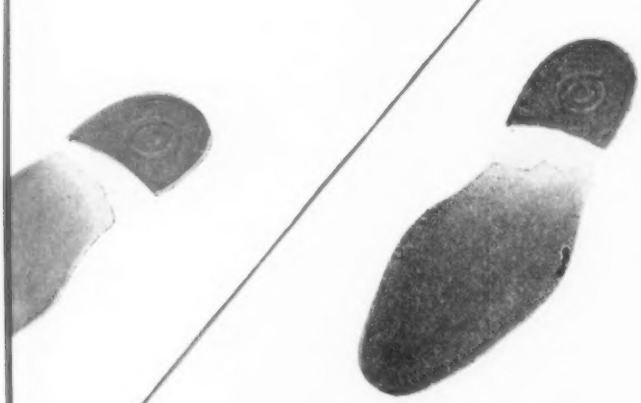
Final in October

This article is the fourth of a series dealing with analytical methods for determining the economic design of pressure vessels. "Economic Gas Storage", fifth and final article in the series, will appear in the October issue of the Technical Section.

The first article dealt with "Factors Affecting Cost of Tanks" (*May* 3, *p. R-282*). "Shape of Heads" was the subject of the second (*June* 7, *p. R-362*), while "Materials and Construction Factors" appeared as the third (*July* 5, *p. R-447*).

IMPORTANT FIRST STEPS

To Great Developments!



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Key Technologists in New Wartime Plants

No. 1 Refinery of Standard Oil Co. (Ohio)

WITH the new 100-octane base stock plant at their No. 1 Refinery in Cleveland now in full operation (*NPN Technical Section, Aug. 2, pgs. R-491-494*), Standard Oil Co. (Ohio) has just recently announced several changes and promotions among the personnel responsible for keeping this vital unit on stream.

Carl H. Metz, Jr., formerly superintendent, is now moved up to the position of refinery manager. Mr. Metz came to Standard of Ohio in August, 1927, as cracking coil stillman at the No. 1 refinery. He was named foreman a year later, assistant superintendent in 1929, and superintendent in August of 1937.

A native of South Carolina, he graduated from The Citadel and then began work as a water drawoff boy for Standard Oil Co. of New Jersey at the Charleston, S. C., refinery. In 1924 he was sent to Tampico, Mexico, as a stillman for Transcontinental Petroleum Co., a subsidiary of Standard of N. J. He spent three years at the Mexico refinery, returning to Charleston for a few months before joining up with Standard of Ohio.

C. H. Metz, Jr.

Ivan L. Peterson has been named superintendent of maintenance and construction, after having served as assistant superintendent since 1937. Mr. Peterson received his B.S. degree in mechanical engineering from the University of Illinois in 1924. That same year he started work with Standard of Ohio's engineering department in the Toledo refinery, served as master mechanic there until 1936, and in 1937 was transferred to the No. 1 refinery in Cleveland.

I. L. Peterson

Edward S. Bale

E. E. Pettibone

Edward S. Bale, who has been in charge of the company's technical service division since Sept., 1939, is now superintendent of process at the No. 1 refinery. Before coming with Standard of Ohio as a process engineer in January of 1939, Mr. Bale was with Standard Oil Co. of New Jersey at their Bayway refinery for five years.

Edward E. Pettibone, as process engineer at the No. 1 refinery, has been co-ordinating the mechanical construction work to the process operations. He started with Standard of Ohio in 1937 as a chemical engineer in the technical service department and in 1941 was transferred to the position of technical advisor to the superintendent at the No. 1 refinery.

Mr. Pettibone holds B.S. and M.S. degrees in chemical engineering from the University of Michigan.

Oscar W. Walter, assistant superintendent in charge of cracking, supervises the operation of four tube and tank cracking units, a gas plant, a debutanizing and stabilizing plant, a catpoly plant, and the 100-octane base stock cat-cracker.

Like Mr. Metz, Mr. Walter started work with Standard Oil Co. of New Jersey, was transferred to Transcontinental Petroleum Co., Tampico, Mexico, and began work with Standard of Ohio in 1927.

Howard G. Briggs, process foreman, was graduated from Cornell university in 1939 with the degree of chemical engineer.

He joined Standard's technical service department as a chemical engineer that same year, and in 1942 was transferred to the No. 1 refinery as a process engineer. In 1943 he was promoted to assistant foreman of the cracking department, and just recently to foreman.

Joseph J. August, Jr., replaces Mr. Bale as chief of the technical service division. He was formerly assistant cracking dept. foreman at the No. 1 refinery.

Mr. August holds a degree in chemical engineering from the University of Michigan, being graduated in 1938. He started working with Standard of Ohio that same year, specializing in process development and process design work.

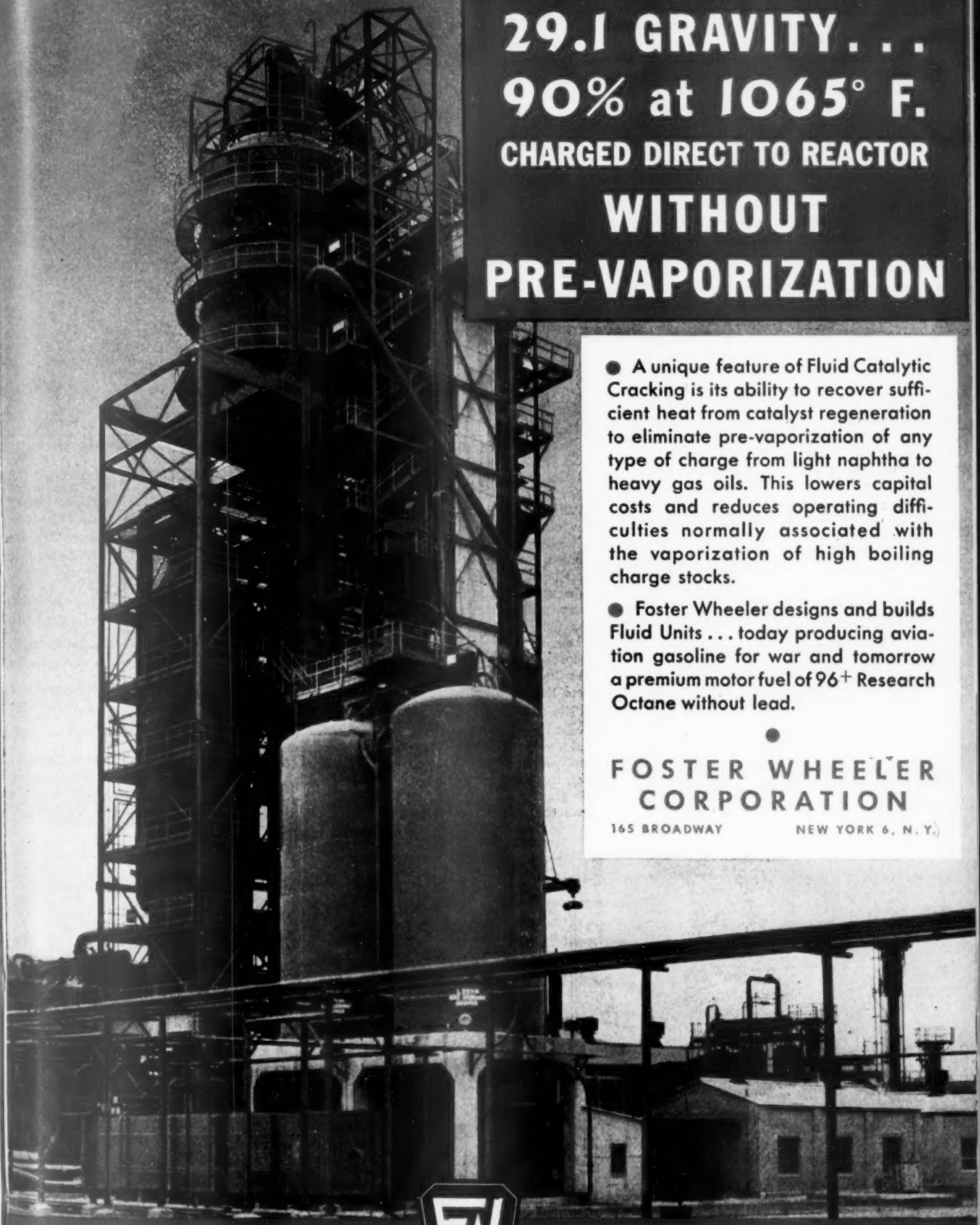
O. W. Walter

H. G. Briggs

Joseph August, Jr.

FLUID CATALYTIC CRACKING

29.1 GRAVITY... 90% at 1065° F. CHARGED DIRECT TO REACTOR WITHOUT PRE-VAPORIZATION



● A unique feature of Fluid Catalytic Cracking is its ability to recover sufficient heat from catalyst regeneration to eliminate pre-vaporization of any type of charge from light naphtha to heavy gas oils. This lowers capital costs and reduces operating difficulties normally associated with the vaporization of high boiling charge stocks.

● Foster Wheeler designs and builds Fluid Units . . . today producing aviation gasoline for war and tomorrow a premium motor fuel of 96+ Research Octane without lead.

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FOSTER WHEELER

Erecting 27 Tanks from Salvaged P
Saved Day for Sour Crude Pipeli

PLATES AND OTHER MATERIALS salvaged from thirty 80,000-bbl. crude oil tanks in the Casper, Wyo., oil field provided storage facilities for the wartime pipeline project of Stanolind Pipe Line Co. connecting the sour crude fields in West Texas with its existing pipeline facilities.

The salvaged materials were used to erect thirteen 85,000-bbl. tanks, four 30,000-bbl. tanks and ten 20,000-bbl. tanks at 15 locations in Texas, Oklahoma, Kansas, Missouri and Illinois.

The new pipeline was built to make West Texas crudes from the Slaughter and Wasson pools available to refineries in PAW Dist. 2, which are called upon to refine an increasing amount of oil to meet essential war needs, in spite of a decreasing supply of crude from normal sources. In addition to connecting with Stanolind's main line to Dist. 2, the new line can deliver crude to the Texas, Texas-Empire, Shell, Empire, Gulf, Sinclair, Oklahoma, Magnolia, Standish, Mid-Continent, Tide Water and Continental lines.

Stanolind Pipe Line Co., with the approval of the PAW and the War Production Board, laid plans to build a line from the two West Texas pools to connect with its facilities at Cushing and Drumright, Okla. The project consisted of laying 383 miles of 16-in. pipe from the Slaughter pool in Hockley county, Texas, to Drumright, Okla.; 10 miles of 8-in. pipe and seven miles of 16-in. pipe to connect to existing lines in the Wasson area; and necessary pumping stations and storage tanks. Capacity of the new line is 64,000 bbls. daily. This can be stepped up to 116,000 bbls. by installing additional intermediate stations.

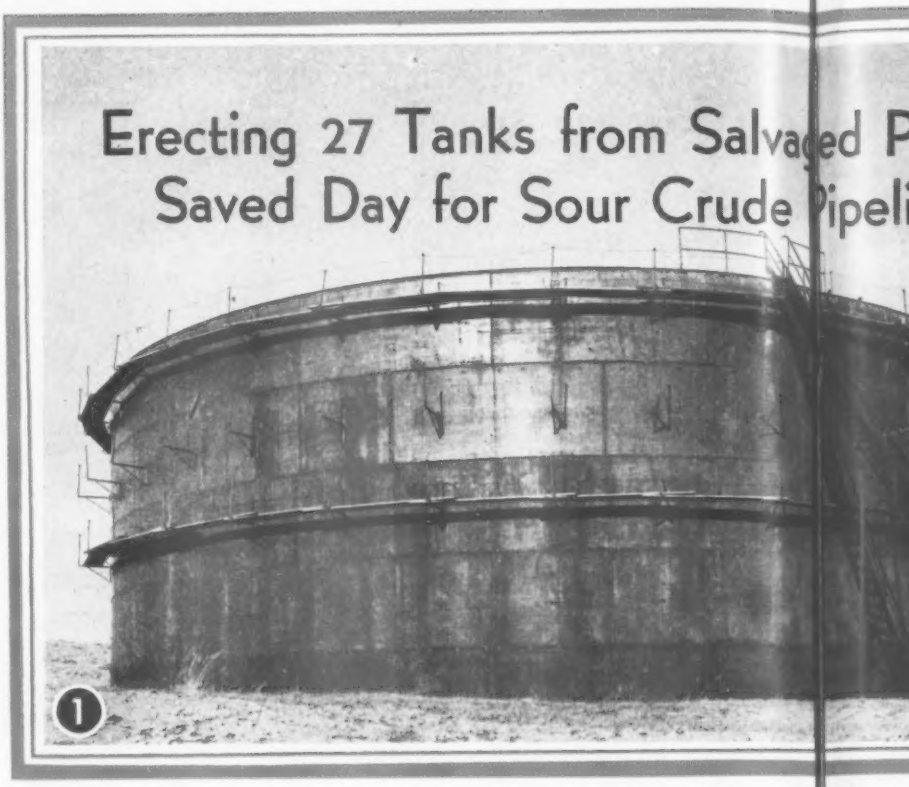
New carbon steel was allotted by the WPB for 390 miles of pipe but it was required that second hand steel plates be used for approximately 95% of the total tonnage required for the tanks. How 27 tanks were erected from salvaged materials is described by an engineer for the Chicago Bridge & Iron Co., which cut down the tanks at Casper, re-erecting them with floating roofs along the line.

*By E. Palmer Shelton**

To build thirteen 85,000-bbl., four 30,000-bbl. and ten 20,000-bbl. tanks from used plates at 15 locations presented a problem of no mean proportions. The only existing tanks available from which suitable material could be obtained were located at Casper, Wyo. These tanks were of riveted construction with conical steel roofs, built in 1922 and 1923, and had been used for crude oil storage. Inspection indicated the plates in the shells and roofs were in good condition and satisfactory for use in re-building tanks. The upper surface of the steel bottoms was in good condition and records showed that, in the Casper area, there was little deterioration on the under side of steel tank bottoms.

The Stanolind Pipe Line Co. decided to use welded construction in rebuilding the tanks and equip them with Wiggins pontoon roofs. Pontoon roofs were chosen for two reasons; first, to reduce evaporation losses and maintain the gravity of the crude and, second, to eliminate the active vapor space above the liquid

*Engineer, Chicago Bridge & Iron Co.



1—One of the thirty 80,000-bbl. cru oil storag were dismantled and rebuilt to s ply storag pipeline project connecting West exas sou cilities. The tank is marked, rea to start off the to

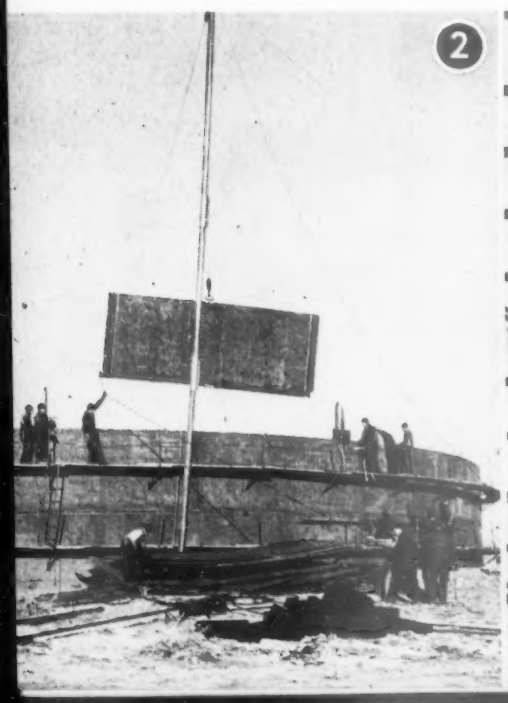
2—A third-ring plate which has en burne mantling process. A stack o plates al

3—Removing roof framing from on of the 80 buggy were used to smantle

4—Checking, cleaning and trimm the she ks by tru

5—Field crew fabricates wind girde sections f

6—First 85,000-bbl. tank rebuilt in e Slaugh of dismantled tanks from Casper, o. Tank wi Wiggins



lvaged Plates
de Pipeline

in the tanks in order to prevent corrosion on the under side of the roofs.

West Texas crude is highly corrosive when the vapors from the crude are allowed to combine with air in the active vapor space of a cone roof tank. Experience has shown that this corrosive characteristic is greatly reduced when the active vapor space is eliminated by using floating roofs.

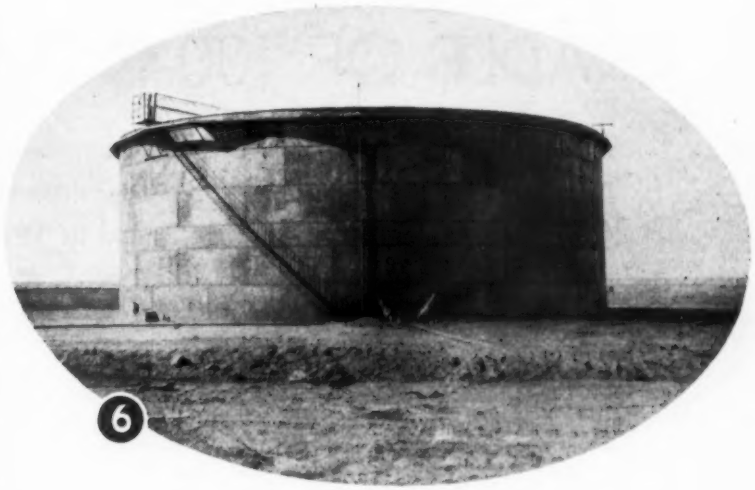
Thirty 80,000-bbl. tanks were dismantled at Casper to provide material for the re-erected tanks. All of the plates for the butt-welded shells and the welded bottoms came from the Casper tanks. The main plates for the decks and pontoons of the floating roofs were also fabricated from plates taken from the dismantled tanks. The only new material in the tank shells and bottoms is in the nozzles and stairways and the only new material in the roofs is that required for the shoes, seals and fittings and miscellaneous small bars and shapes.

The tanks were dismantled by burning off the edges of the plates adjacent to the riveted joints without removing the rivets. A burning machine was devised to cut along both sides of the riveted seams in the roof plates simultaneously.

The old tanks were first cleaned and the wax removed from the inside of the tank shells. Before starting to cut down the tank shells, all plates were carefully marked and scaffolding erected from which to operate the burning machine. A burning machine was also developed to cut above and below the horizontal seams at the same time. The ends of the plates were cut off by burning a single cut with a torch, first on one side of each riveted vertical joint and then on the other.

The dimensions of the tanks to be rebuilt were determined so that each plate, as it was dismantled, was cut to fit into the particular tank for which it was intended. When dismantling the old tanks, care was taken to burn the plates so that the edges would be suitable for re-erecting as butt-welded structures.

The fitting up and the welding of the tanks as they were rebuilt presented problems not encountered in the erecting of butt-welded tanks from new steel plates. As could be expected, the plates were not cut as accurately as had they been fabricated in a shop. Considerable time and expense were required to assemble the plates, fit them up and weld them. Because of the increased number of welded seams on account of the recovered plates being smaller than those ordinarily used in new tanks, care was required to make the tank shells true and round. With close supervision, however, many of the re-erected tanks are as smooth in appearance as tanks built from new steel.



-bbl. cr oil storage tanks in the Casper, Wyo., oil field which uilt to s ply storage for the Stanolind Pipe Line Co.'s wartime g West exas sour crude fields with its existing pipeline fa- ed, rea to start dismantling, with scaffolding in place to cut off the top angle

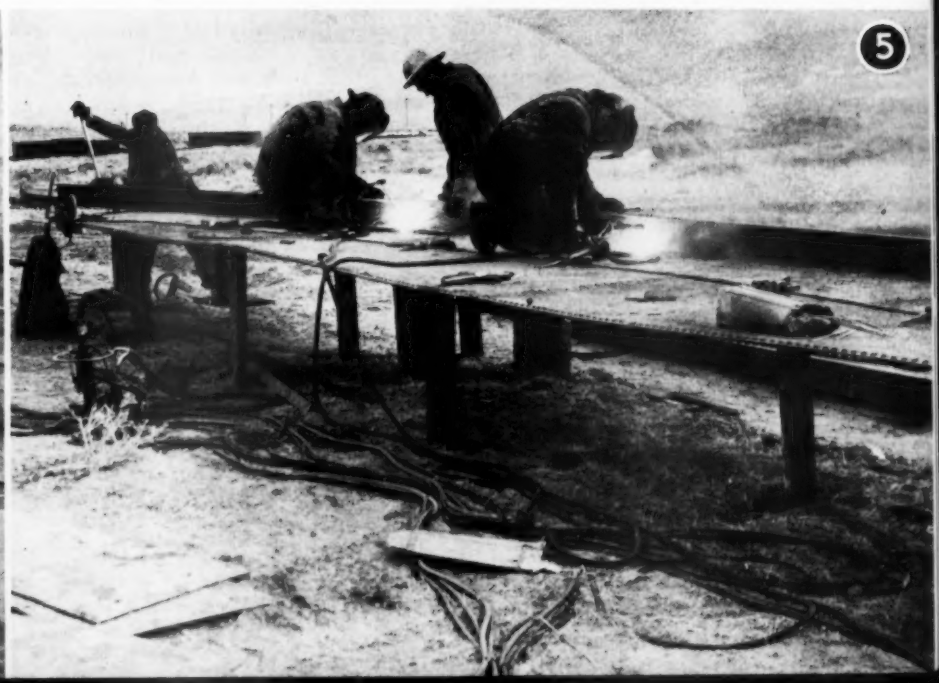
ch has en burned from the tank is lowered during the dis- stack o plates already removed is at bottom of gin pole

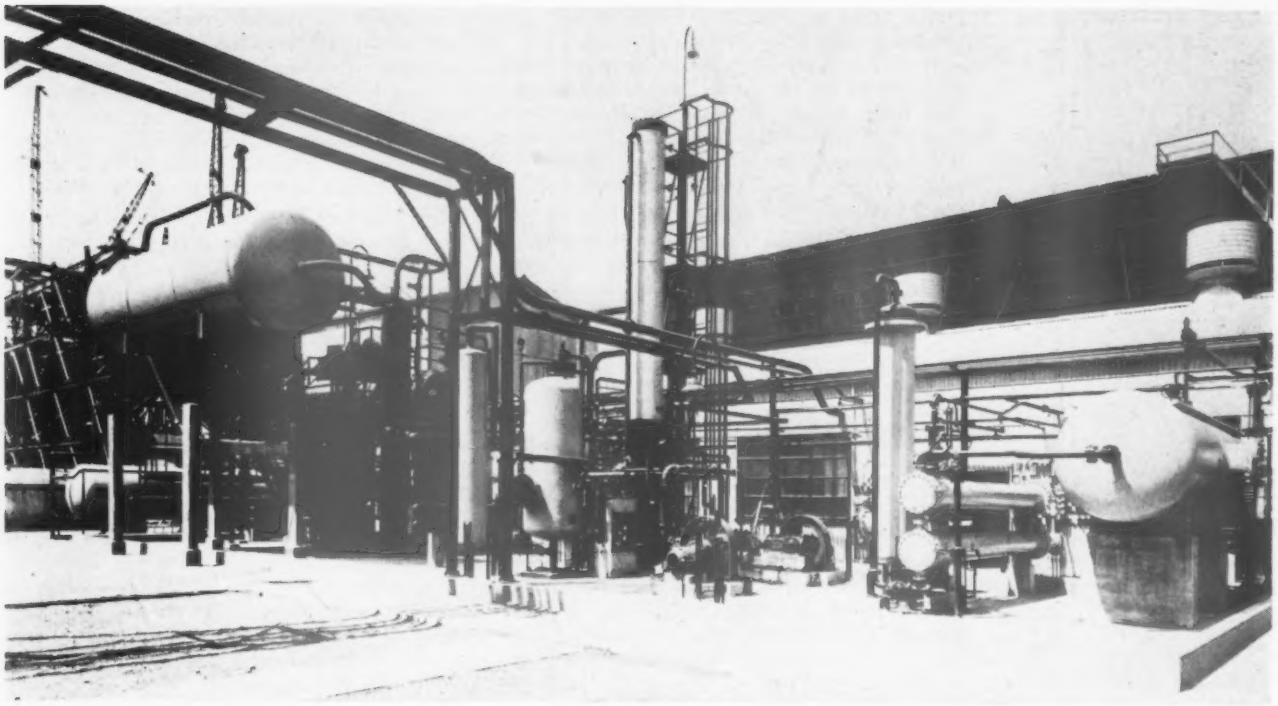
from on of the 80,000-bbl. tanks. Pipe columns and structural used to smantle structural members of the tanks

d trimm the shell plates prior to shipping to site of rebuilt ks by truck and rail

ind girde sections for rebuilt tanks, using material from old tanks

ebuilt in e Slaughter field, near Brownfield, Texas, with plates Casper, o. Tank is of butt-welded construction, and equipped wi Wiggins pontoon roof





Toluene isomerization section at Wood River refinery of Shell Oil Co., Inc.

CRADLE OF 100-OCTANE GASOLINE

New Processes Have Been Installed To Increase Yields of Both Base Gasoline and Alkylates at Refinery Whose First Iso-octane Plant Was Installed in 1935

WITH THE putting into operation of twin Fluid Catalytic Cracking process units, formally dedicated April 30, the capacity to produce aviation gasoline at the Wood River Refinery of Shell Oil Co., Inc., has reached approximately 15,000 barrels a day.

Just 10 years before the ceremonies for the new units, on April 30, 1934, the first shipment from any oil company of 100-octane gasoline to the U. S. Army was made by Shell. In amount it was 1000 gallons. The company's production of aviation gasoline then was only a few hundred barrels a day. The improvements that have been made at Wood River in the past decade typify the achievement of the entire oil industry in insuring supplies of high quality aviation gasoline to meet military requirements.

The first shipment of 100-octane fuel, the "super" aviation gasoline of that time, was practically pure iso-octane, which was made by the cold acid polymerization and hydrogenation process of the Shell company. This process replaced production on laboratory scale which produced iso-octane at a cost of $25 per gallon.

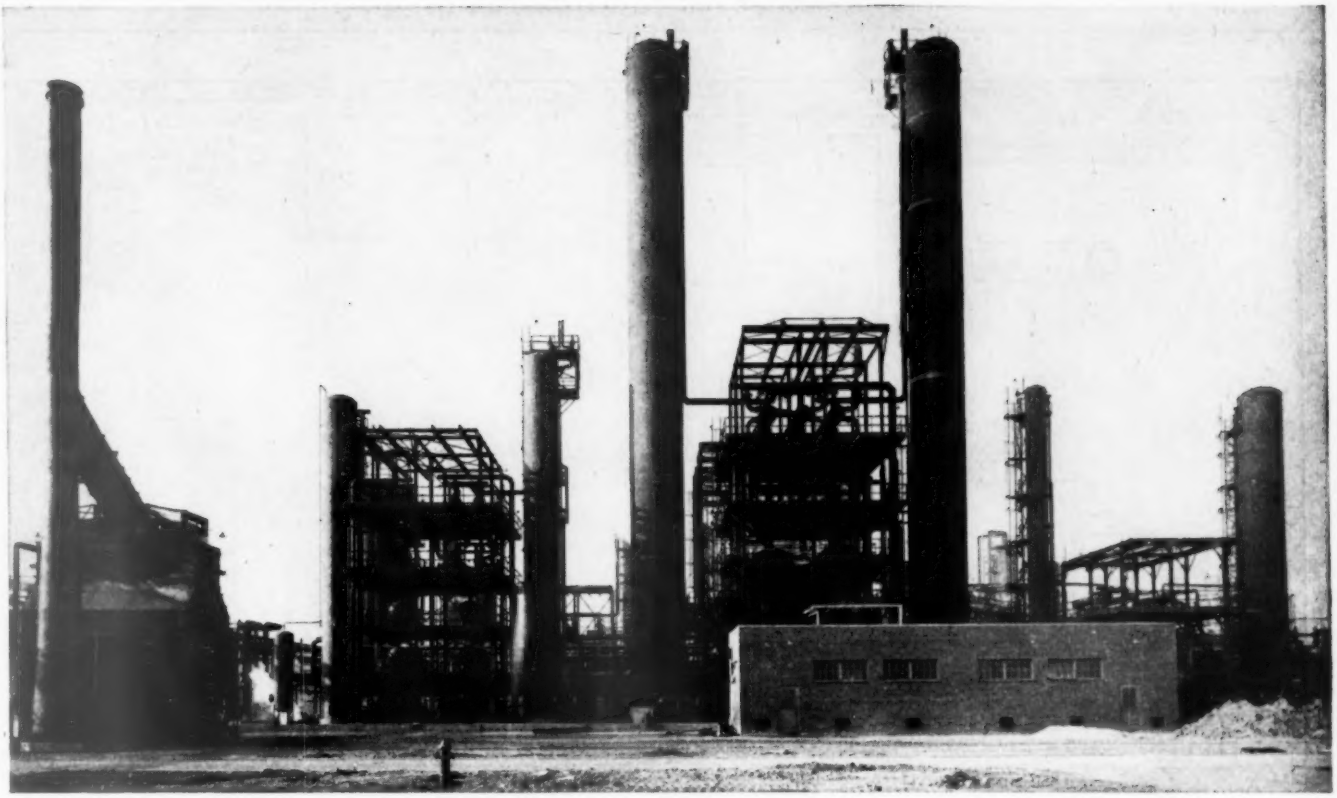
Later, as additional experience was gained, it was found that by blending with selected naturally occurring base stocks and adding tetraethyl lead, the iso-octane content of 100-octane aviation could be reduced and the volume of finished gasoline more than doubled.

While the output of aviation gasoline from the Wood River refinery has been greatly increased year by year through improvements in straight distillation and thermal cracking, it was necessary in order to meet wartime requirements to obtain some process that would give more base stock and more materials for alkylate. This led to the installation of the twin units of the Fluid Catalytic Cracking process, with a combined charging capacity of approximately 30,000 barrels a day. Charge to the "cat" crackers in part is bottoms from the crude topping stills which are then charged to a vacuum flashing section, where a 60% overhead cut is taken as feed for the catalytic crackers. In part, also, feed is a gas oil cut taken off during the topping operation.

The two fluid catalytic units are of the improved standard design and operate without a furnace. Preheating is secured by two steps; first, heat exchange with the slurry from the first fractionating tower for separating products from the cracker and, second, by introducing the heated regenerated catalyst into the liquid charge on its way to the reactor. The heat from the catalyst in direct contact vaporizes the charge before the reactor is reached and also supplies the heat for the cracking reaction.

The flue gases, products of combustion in the regenerators of the catalytic cracking units, pass through waste heat steam boilers which produce 2,500,000 pounds of steam a day, which is used in the operation of the turbines and pumps and for later processing. The flue gases are passed through electrostatic precipitators which recover the catalyst and return it to the system.

In building the catalytic cracking plant, as in other phases of the refinery expansion program at the Wood River plant, construction was hastened and thousands of dollars worth of critical materials saved by the use of obsolete equipment. The stoves and reaction chambers of an old True Vapor Phase cracking unit are now used to store hot and cold catalyst. Four old Dubbs cracking units are used as flashers in preparing the feed for the crackers after it comes from the topping operation. Compressors to the extent of 2500 horsepower of the total 5500 used in the "cat" crackers were the result of salvage.



Fireworks for the enemy

On Tuesday, the Fourth of July, 1944, the world's largest U. O. P. hydrogen fluoride alkylation unit shown above ticked off the one-millionth barrel of alkylate it had produced since it started in operation a year ago It is still producing at the same rate

Alkylate is the component that puts the zip in 100-octane gasoline

That million-barrel unit is an integral part of the giant new refinery built by the Sun Oil Company at Marcus Hook, Pa., to produce superaviation motor fuel for our fighting flyers

It is one of scores of Universal units that are leading in the production of fighting aviation gasoline and other war materials

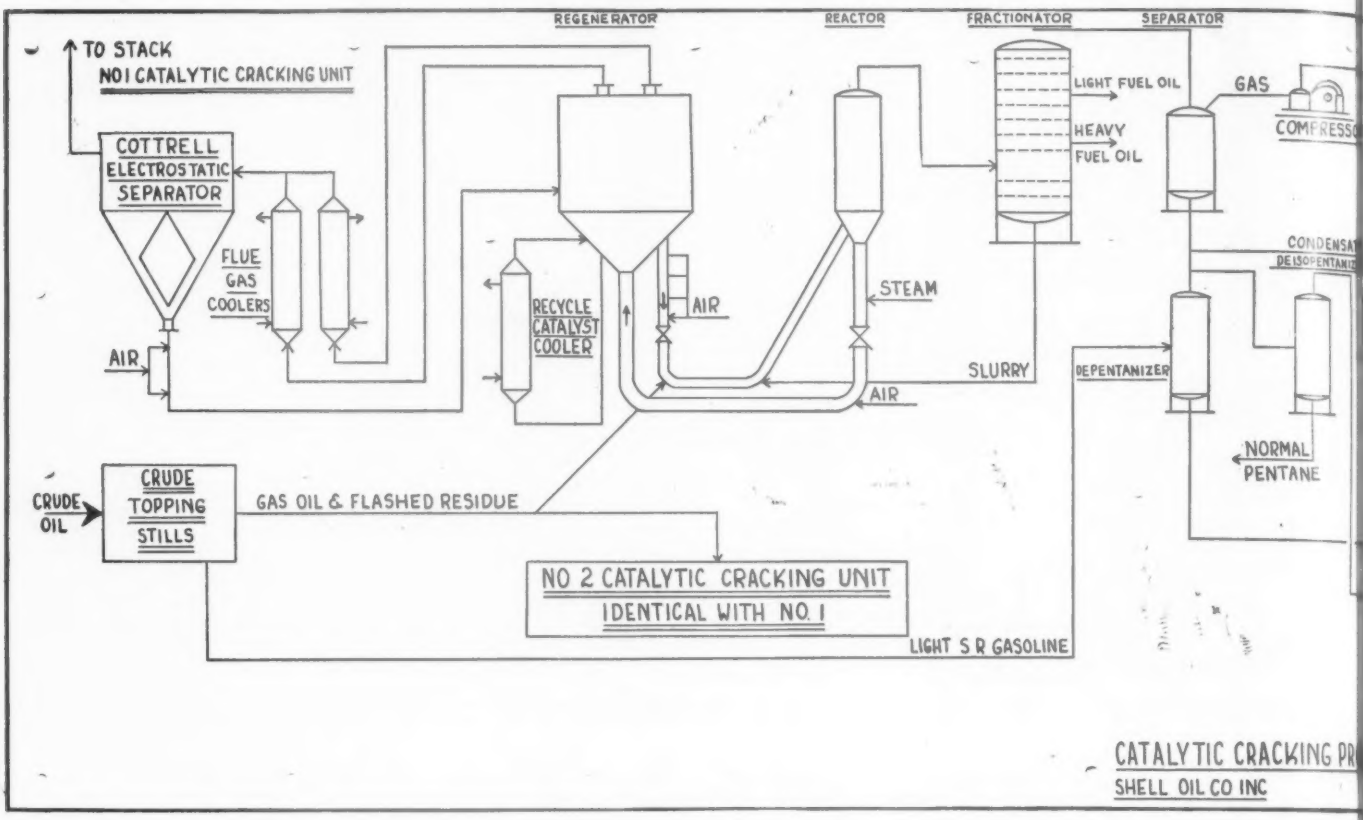
Universal Oil Products Co.
Chicago 4, Ill., U. S. A.

UOP

Petroleum Process Pioneers
For All Refiners

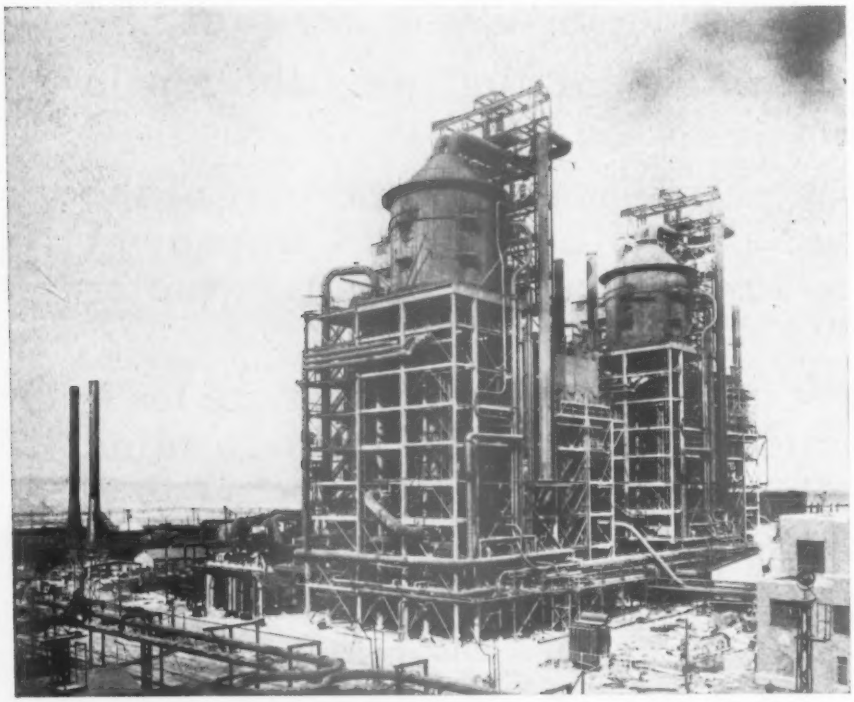
The Refiners Institute of Petroleum Technology

GASOLINE POWERS THE ATTACK—DON'T WASTE A DROP



Of the total 12,500 tons that went into the construction of the twin catalytic cracking units, over 2500 tons was salvaged material. On the total expenditure of $15,000,000 for these units, about $2,500,000 was saved by the use of salvaged equipment.

Gases from the catalytic crackers are treated in a separate gas recovery system from those from the thermal crackers. They pass through a two-stage compression system, thence to an absorber where methane and ethane are recovered for fuel purposes. The absorbed gases are separated from the enriched oil in a fractionator, and then debutanized and depropanized.



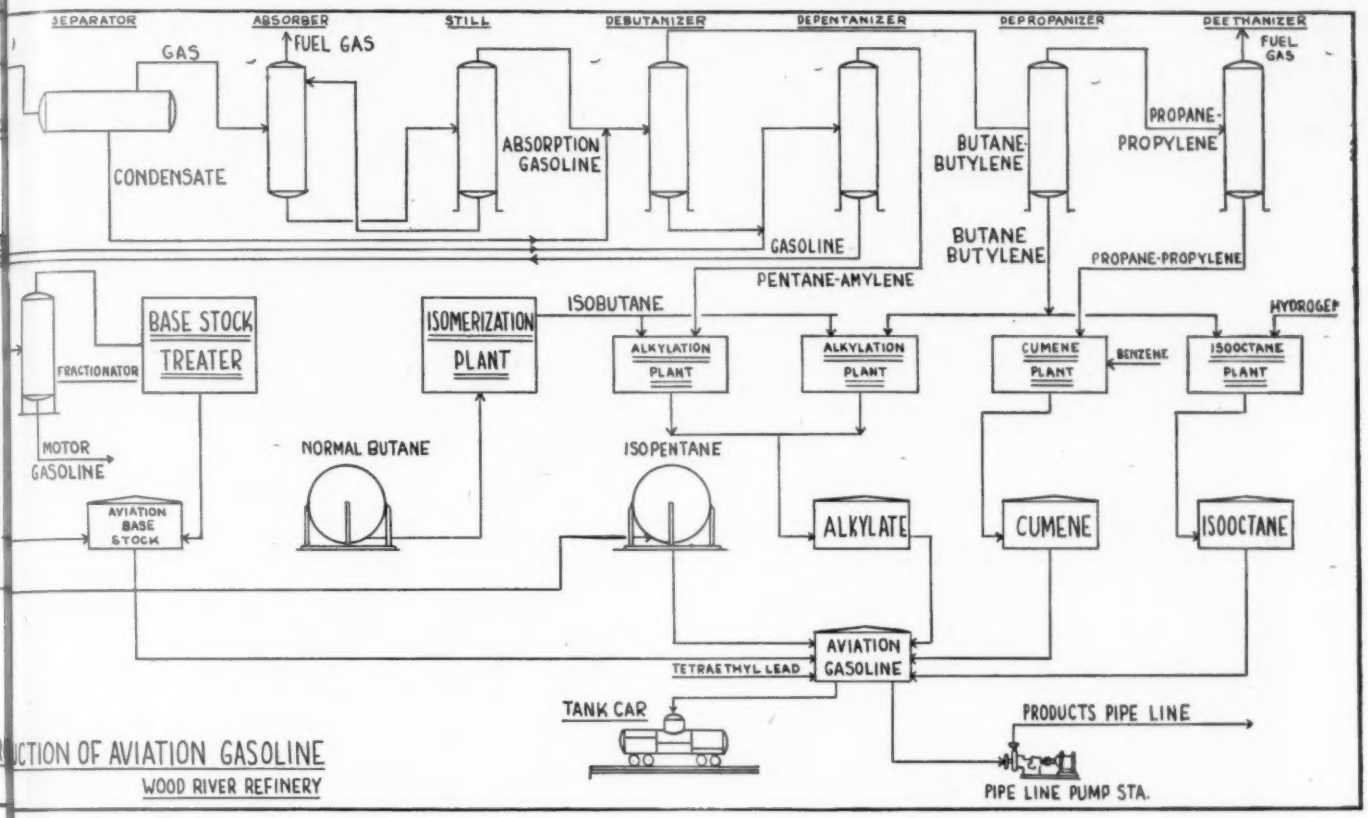
Twin Fluid Catalytic Cracking units of standard design at Shell Oil Co.'s Wood River refinery, with combined charging capacity of 30,000 bbl. a day. Two-step preheating of the charging stock eliminates the need for a furnace

Bottoms from the debutanizer, the C_5 and C_6 fractions, are separated, the pentanes going to the pentane plant and the C_6 fraction, mostly isohexane, being blended with the catalytic gasoline base stock. Bottoms from the depropanizing column, the C_4 fraction, supply charge to the alkylation plant. Propane and lighter fractions from the depropanizing step are charged to a common deethanizer for both the thermal and catalytic gas recovery systems from which the C_3 fraction is secured for feed to the cumene plant.

Liquid products from the catalytic crackers consist of a long cut of gasoline of about 435 end point, distillate fuel oil, and a heavy gas oil that is charged to thermal cracking. Under present operations the gasoline fraction is cut back to about 325 end point by tower distillation and conventional fractionation. It is acid treated and redistilled for removal of sulfur and partial removal of olefins.

Crude Processing

Crude capacity of the Wood River plant is around 85,000 b/d, the major part of the crude received being West Texas oil containing 1.5% sulfur and around 100 lb of salt per 1000 bbl. A



CTION OF AVIATION GASOLINE
WOOD RIVER REFINERY

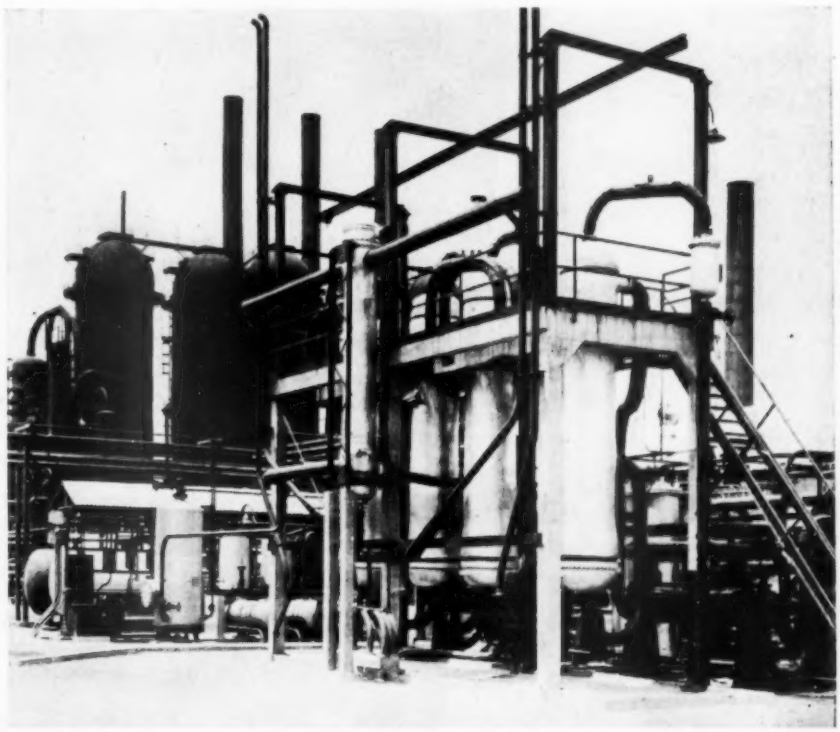
minor part of the crude is a "sweet" Mid-Continent oil for the manufacture of lubricating oils, from which selected gasoline cuts are also taken. The Shell company has had long experience at this plant in running "sour" crude of the type of the West Texas oil and in processing it into quality products. The salt is removed by washing before processing. The processing is in conventional equipment, corrosion-resistant alloys being installed in the critical temperature zones where necessary to protect the equipment. Products are treated to reduce the sulfur compounds to specification levels.

All the incoming crude is topped. The plant has two topping units of 35,000 b/d capacity each and one of 15,000 bbl. The fractionator section for the topping units consists of three towers with reboilers, with two take-off strippers on the third column. The first fractionator takes off pentanes and lighter fractions. Dependentanizing the overhead from the topping operation makes possible the recovery of these fractions from crudes not intended for the manufacture of aviation gasoline and gives the plant a maximum isopentane recovery.

The straight-run gasoline cut taken off at the topping unit contains the aviation gasoline fraction. This goes to the toluene plant where the toluene fraction is removed. The remainder then undergoes further distillation, treating and sweetening, to secure material suitable for aviation gasoline base stock.

Fuel distillates are taken from the third column of the topping unit fractionating section. One is further treated for furnace oil and the other is part of the charge to the catalytic cracking units. Bottoms from this column go to the vacuum flashing section earlier referred to, from which the overhead goes as charge to the catalytic crackers.

Some features of the processing at Shell's Wood River refinery to increase



Iso-octane unit installed at Wood River refinery in 1935 which is still in operation

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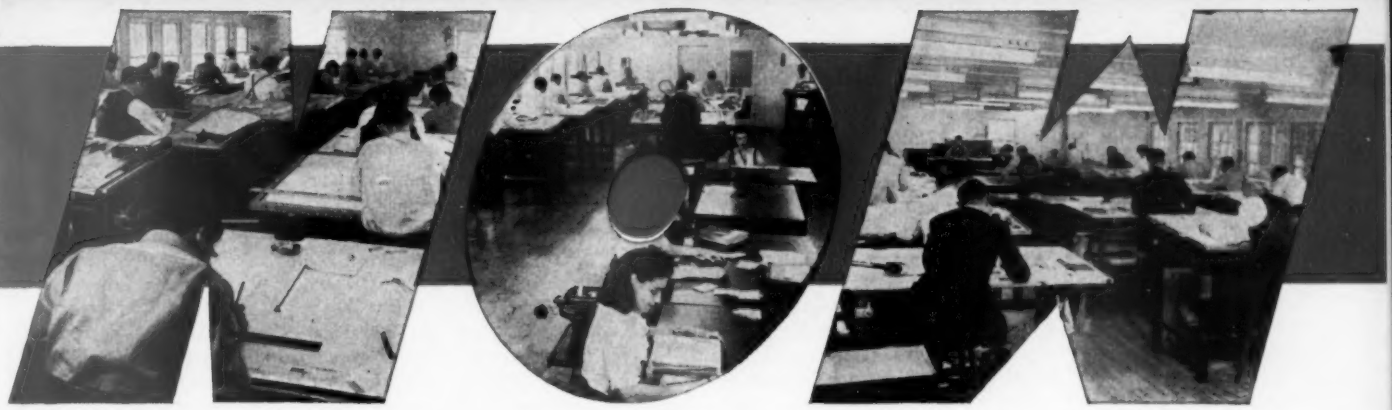

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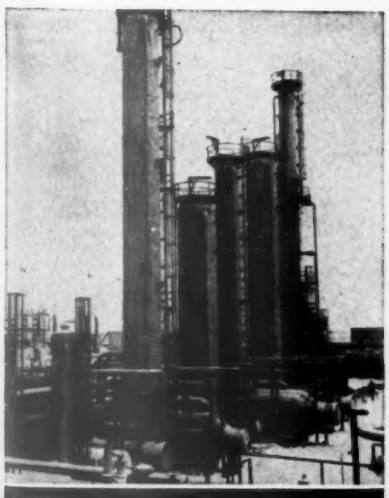
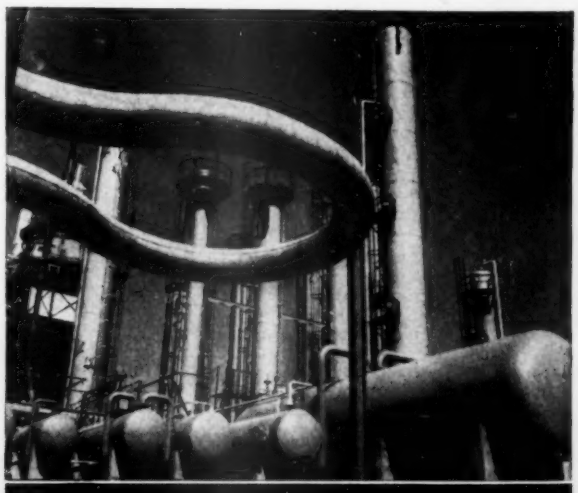


VAPOR RECOVERY UNIT



ALKYLATION UNIT

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ENGINEERING & CONSTRUCTION DIVISION

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the yield of aviation gasoline are described briefly as follows.

The pentanes and lighter fraction taken off in the topping operation go first to a debutanizing column which removes the C_4 and lighter hydrocarbons. Next step is the separation of the pentanes and hexanes in a 70-tray depentanizing tower. Normal and isopentane are then separated in a deisopentanizer. Overhead from this column consists of isopentane. This overhead is treated for the removal of sulfur compounds. Bottoms from the deisopentanizer are mainly normal pentane which is used in motor gasoline.

Two-Process Toluene Plant

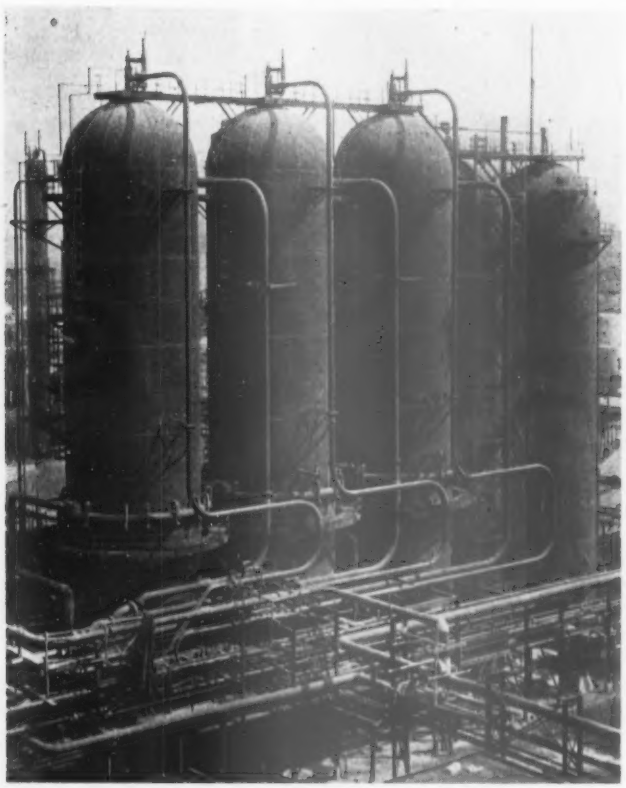
The toluene plant of the Wood River refinery of Shell Oil Co., Inc., combines the extractive distillation toluene recovery process with a method of synthesis. Both were developed by this company. This latter method involves the dehydrogenation of methylcyclohexane. The process is similar to the hydroforming process which was originally used for reforming heavy naphthas of low-octane characteristics into a high-octane gasoline with good aromatic content. Toluene plants at oil companies over the country have so fully met the military requirements for toluene for the manufacture of TNT that part of the output of this product at Wood River, as at many refineries, is now being used as a 100-octane gasoline component, valuable both for its high octane number and aromatic characteristics.

First operation in the toluene unit is the processing of the gasoline fraction from the crude topping operation. In a prefractionator the higher boiling point material is removed, which, after further distillation and treating, becomes an aviation gasoline base stock. From the remainder a dimethylcyclopentane cut is taken, which is then isomerized to produce methylcyclohexane. The rest of the charge goes to a column which produces a charge for the dehydrogenation reaction. The producing of additional methylcyclohexane through isomerization greatly increases the volume of the material which can be dehydrogenated into toluene.

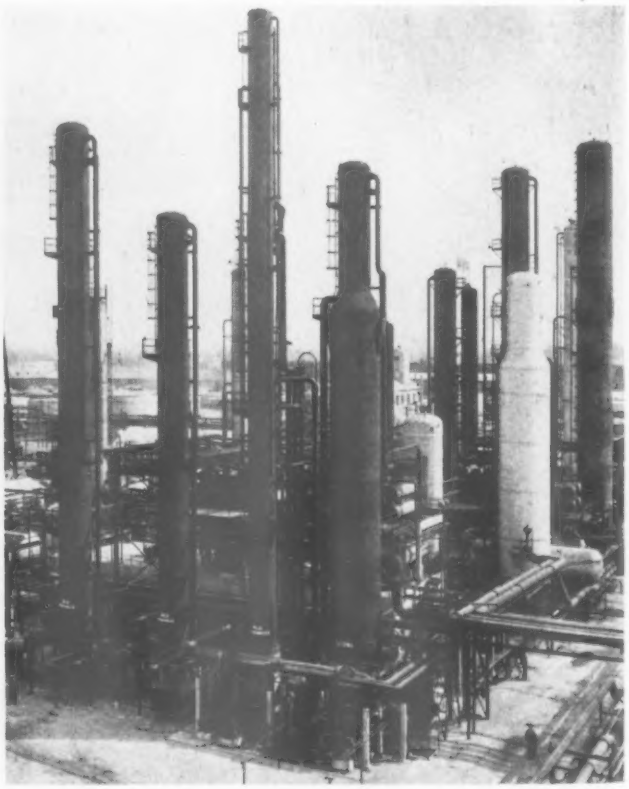
The dehydrogenation reaction is catalytic. The charge is a methylcyclohexane fraction of 200-250°F. boiling range. It is vaporized in a preheater before passing to the reactor. The processing here is done in a single pass. The product is a toluene concentrate which is sent to the extractive section, where the toluene is solvent removed from the concentrate and acid treated to the nitration grade if the product is desired for explosives manufacture. Acid treatment is not necessary if it is to be a component of aviation gasoline.

The cumene plant also employs a process first put into commercial operation by Shell Oil Co. for making this aromatic blending agent for aviation gasoline. The process is adaptable to existing polymerization units with relatively minor modifications, which include installation of additional fractionation capacity for the separation of benzene and additional heat exchange capacity required by the higher operating temperatures. The process has been installed in many other refineries over the country to aid in building up the oil industry's output of aviation gasoline.

Cumene (isopropylbenzene) is a product of the alkylation of benzene and propylene. In the Wood River refinery the C_3 fraction is obtained from the gases from thermal and catalytic cracking and contains about 30% propylene and 70% propane. The benzene, a by-product from coking coal is obtained from outside sources. The feed is combined and preheated before entering the reactor by exchange with the reacted products. The product from reaction is depropanized and debenzenized. Bottoms from the debenzenizing column are fed to a fractionator, the finished cumene being the overhead product from the tower.



Reaction chambers of an old True Vapor Phase cracking unit at the Wood River refinery are now used in storage for catalyst for the catalytic cracking plant



Gas recovery plant at the Wood River refinery. The four towers in the foreground treat light ends from the catalytic cracking unit; others are columns for light fractions from topping operations

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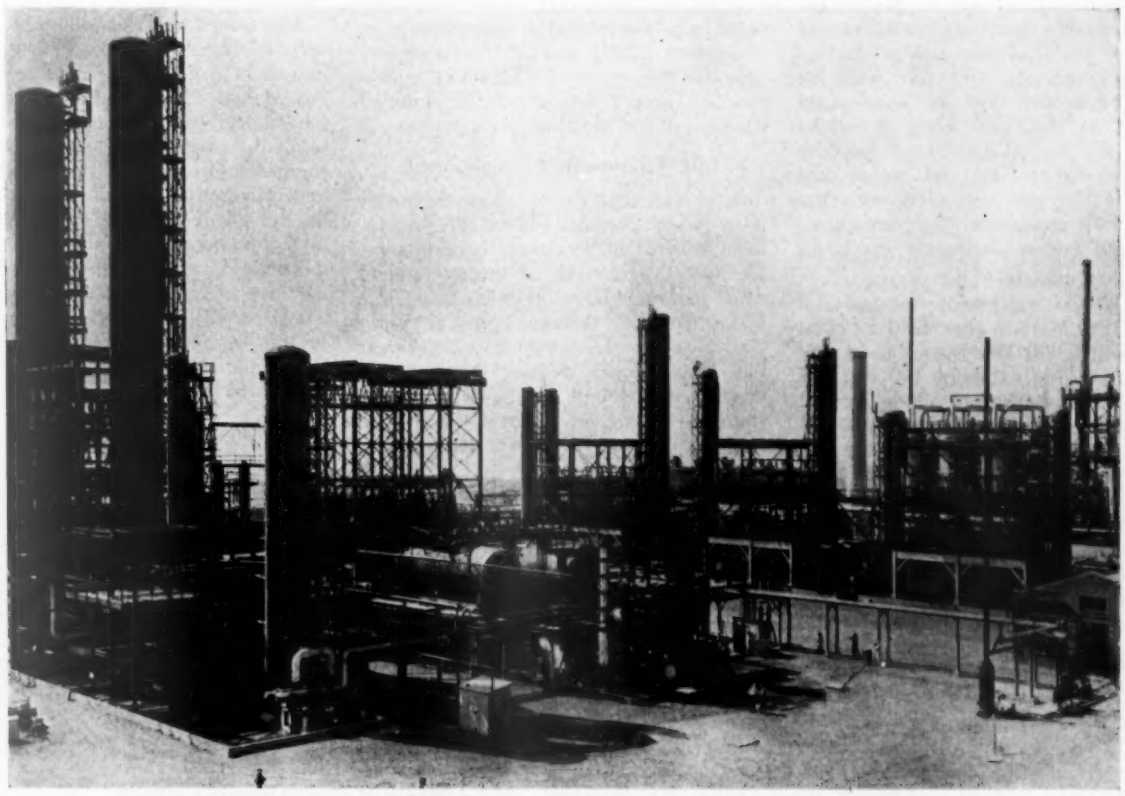

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DESIGN and CONSTRUCTION of SANTA MARIA VALLEY ABSORPTION PLANT*

Because of Wartime Material Shortages Nearly All Major Units Were Built of Salvaged Equipment

*By D. E. McFaddin***

Features are described of a complete absorption plant designed to process 18,000,000 cubic feet per day of gas produced in connection with a high sulfur content crude, with an absorption oil circulation of 16,000 gallons per hour. Recovery of 80% of the iso-butane content is achieved, 97.5% of the normal butane and 99.2% of the pentane and heavier content. About 70% of the hydrogen sulfide in the gas is removed by soda ash treatment and the remainder by treatment in iron oxide beds.

The Santa Maria Valley oil field was discovered by the Union Oil Co. of California in 1934. The oil from this field is heavy, running about 15° API gravity, and has a high sulfur content. During the first three years of the life of the field there was practically no demand for oil of this character and production was at a minimum. However, with the coming of World War II the demand increased so that now there is urgent demand for the maximum oil production. The conservation and proper utilization of the gas associated with the increased oil production has consequently required the installation of gas treating and handling facilities.

In 1937, gas equipment was installed in the Santa Maria Valley field to compress about 5,000 MCF per day of wet gas from 20 psig to about 150 lbs. and to remove the hydrogen sulfide content of the gas by means of an iron oxide bed, and then to transport the gas through 7 miles of 6-in. pipe to Union Oil Co.'s Orcutt absorption plant. Facilities were available there to recover the gasoline content. The surplus dry gas was delivered into the Southern Counties Gas Co. lines.

This operation was satisfactory for several years but by the early part of 1942, production had increased until it was apparent that a complete absorption plant was needed in the Santa Maria Valley field. It will be remembered that at this time very little new material was available for constructing an absorption plant, and it was necessary to comb the country for idle used equipment. Table I lists the major units of equipment and indicates their source.

Idle Equipment Reconditioned

It is seen that nearly all of the major units were obtained from idle equipment which had previously been in service many years. All of this equipment was thoroughly reconditioned in the Union Oil Co. salvage shops at Santa Fe Springs. In some cases, 15-year old "bare rod" welding on pressure vessels was found to have a tensile strength insufficient to meet the desired working pressure. This bare rod welding was chipped out and the vessels rewelded according to modern standards. Pumps, safety valves and instruments were also a very difficult problem and many items of this class were rebuilt in Union Oil Co. shops from equipment which had long been discarded.

Engineering the process and construction of a plant with such a limited availability of equipment presented many unusual problems. Nevertheless, with help from WPB District 5 office, the necessary priorities were obtained and construction was started on April 15, 1943. The plant was completed and put into operation Dec. 30 of the same year.

The Santa Maria Valley absorption plant was designed to process a maximum of 18,000 MCF per day with an absorption oil circulation of 16,000 gal. per hour and an absorber pressure of 190 lbs. gauge, extracting 80% of the iso-butane content, 97.5% of the normal butane and 99.2% of the pentanes and heavier content of the gas. Table II gives the overall plant commodity balance.

The gas from the field reaches the plant at approximately 23 lbs. gauge and is compressed to 210 lbs. in two stages. At the interstage pressure of about 75 lbs. the gas is countercurrently contacted with 4% soda ash solution to remove the major portion of the hydrogen sulfide. The remainder of the hydrogen sulfide is removed by iron oxide beds after the gas has been compressed to 210 lbs. The iso-butane and heavier fractions of the gas are then extracted from the gas by absorption oil circulated through absorbers operating at about 190 lbs.

The water vapor content of the absorption plant discharge gas is then removed in a Southern Counties Gas Co. gas dehydration plant, employing diethylene glycol, in order to prevent subsequent condensation and corrosion in the gas company's fuel gas transportation and distribution system. A large portion of the plant discharge gas is utilized in the Santa Maria Valley area for domestic and industrial purposes. The remainder is transported to Union's Orcutt compression plant where it is compressed to 400 lbs. and delivered into the Southern Counties Gas Co.'s main lines running to Santa Barbara.

Fig. I, the flow chart of the plant, (see page R-620), shows that the absorption plant cycle is quite simple. There are two absorbers. Each is 46 in. I.D. and 24 ft. high and contains 15 perforated trays. The absorption oil is metered to the top of each absorber and flows from tray to tray downward, countercurrently against the rising gas. Liquid level controllers automatically hold a constant oil level in the bottom section of each absorber. The main stream of enriched oil from the bottoms of the absorbers flows through inter-

*Presented before the California Natural Gasoline Assn., Los Angeles, July 6, 1944.

**Senior Process Engineer, Union Oil Co., Los Angeles.

Table II—Overall Plant Commodity Balance, Santa Maria Valley Absorption Plant

	18,000 MCF/Day Intake Gas			Extracted Products				17,280 MCF/Day Discharge Gas		
Component	Gas Vol. Per Cent	Gal/ MCF	Gal/ Day	29# Reid V. P. Gaso. Gal/Day	Iso-Butane Side Cut Gal/Day	Total Liquids Gal/Day	Liquid Extraction Per Cent	Gas Vol. Per Cent	Gal/ MCF	Gal/ Day
Hydrogen Sulfide	25 gr/100 C.F.							.00		
Water Vapor	0.30							.05		
Air	1.00							1.00		
Carbon Dioxide	8.80							9.20		
Methane	79.83				10	10		83.10		
Ethane	3.87				25	25		4.02		
Propane	3.19				1,120	1,120		2.48		
Iso-Butane	0.51	0.167	3,006	240	2,166	2,406	80	0.11	0.035	600
Nor-Butane	1.22	0.383	6,894	6,200	524	6,724	97.5	0.03	0.01	170
Pentane and Heavier	1.28	0.500	9,000	8,930		8,930	99.2	0.01	0.004	70
Total	100.00			15,370	3,845	19,215		100.00		

Table 1—Source and Description of the Main Units of the Santa Maria Valley Absorption Plant

COMPRESSORS

One 150 H.P. model XVG Ingersoll-Rand compressor.
350 rpm.
One low stage cylinder 12 in. x 14 in. with variable clearance.
One high stage cylinder 8 in. x 14 in.
Eleven Cooper Type 80 twin compressors.
200 rpm.
One low stage cylinder 13 in. x 20 in. with clearance chambers.
One high stage cylinder 8 in. x 20.
The Coopers were fitted with special cams to enable developing the maximum horsepower.
The Cooper power cylinders were also adapted to overhead air intakes and were equipped with Vortox air cleaners.
The Ingersoll-Rand XVG and three of the Cooper 80's had been installed at the plant location prior to the construction of the absorption plant in 1943.
All the additional compressors had previously been in service at various locations many years and required extensive repair work before being put into service in the new plant. The Coopers are now developing about 185 brake horsepower; and were originally rated by the manufacturer at 175 brake horsepower.

ABSORBERS

Two 46 in. I.D. x 25 ft. high absorbers, previously used in a North Belridge Absorption plant were adapted for use at Santa Maria. These vessels had been operated at 400 lbs. gauge for many years, but under present code standards they are rated at 200 lbs. gauge maximum allowable working pressure.
Each absorber has a computed maximum capacity of about 11,000 MCF per day at 200 lb. gauge with an oil circulation of 8,000 gal. per hour.
In order to obtain this capacity the total number of perforations in each tray was increased from 1900 to 5700 and new larger inlet and outlet nozzles were installed. The perforations are 9/64 in. in diameter. Each absorber originally had 16 trays. However, it was necessary to sacrifice one tray in each absorber to accommodate the new nozzles.

INTERCHANGERS

Six Braun F-155 units with a total heat transfer surface of 2200 sq. ft. were obtained from a dismantled absorption plant at Elwood. They were installed in two parallel banks, each with three units in series. A heat transfer K of 100 Btu. per sq. ft. per degree F. temperature difference is being obtained with these units, which is very good performance.

RICH OIL FRACTIONATOR

A 32 in. I.D. x 50 ft. high column with 22 bubble cap trays was obtained for this service. It was formerly used as a stabilizer column in an Elwood absorption plant and originally had a maximum allowable working pressure of 250 lb. gauge, however, this was reduced to 170 lbs. gauge in accordance with present safety code standards.

PREHEATERS

Two Braun F 150 units with a total heat transfer surface of 750 sq. ft. were obtained from a dismantled plant at Elwood. These units are now performing with a heat transfer "K" of over 200 Btu./sq. ft./°F.

FRACTIONATING-STRIPPING STILL

A 60 in. I.D. x 55 ft. high column with 19 perforated trays was obtained from Union Oil Co.'s Bell absorption plant at Santa Fe Springs where it had been standing idle for about 10 years. It has a 55 lb. maximum allowable working pressure; built in oil reheaters, and facilities to withdraw stripping steam condensed within the fractionating section of the column. The perforations of the fractionating trays for this column had previously been drilled beyond the limit of efficient performance for the conditions at the Santa Maria absorption plant. Therefore about 50% of the perforations were blanked off with plates of sheet metal. They are performing satisfactorily.

STABILIZER

A 32 in. I.D. x 77 ft. high column with 40 bubble cap trays, together with interchangers and a reboiler, were obtained from Union Oil Co.'s absorption plant at Del Rey, where they were standing idle. They had been in corrosive service for about 12 years. However, after some repair work, a maximum allowable working pressure of 230 lbs. was obtained, which is only 20 lbs. less than the 250 lb. working pressure allowed when the vessel was first built.
This vessel was originally equipped with a reflux condenser located on its top. This part of the equipment was in bad condition and was junked. The unit was then redesigned to operate with a reflux tank at ground level with condenser coils located in a cooling tower. The reboiler was also redesigned and augmented. Side draw-off connections were provided between the feed inlet and column top for the production of an iso-butane cut or of liquefied petroleum gas.

OIL CONDITIONER

A 20 in. diameter oil conditioner was constructed entirely from salvaged material to separate gums and foreign matter from the oil.

changers, where it is heated to approximately 290°F. It then flows into a rich oil fractionator at 100 lbs. pressure. This unit is installed to separate the major portion of the methane and ethane from the absorption oil and other absorbed fractions.

Gasoline Content Is Low

The gasoline content of the plant intake gas from the Santa Maria Valley oil field is unusually low. This fact has a direct bearing on the condensation and separation of the gasoline and iso-butane and propane from the lighter absorbed fractions. When theoretical computations were made to determine the proper process cycle it was found that either a high pressure (100 lb.) still, a rich oil fractionator or some other facility was required which would eliminate the major portion of the methane and ethane from the cycle before the main (40 lb.) raw gasoline condenser was reached. Otherwise these light fractions would prevent the satisfactory condensation of the other fractions, especially of propane and the butanes.

The use of a 32 in. I.D. rich oil fractionator was found to be the best suited to the present requirements at the Santa Maria Valley plant. The rich oil and vapor from the interchangers at 290°F. enters the bottom section of the column where the liquid is separated from the vapor. The liquid flows out the bottom to the preheaters, while the vapor rises upward through fractionating trays countercurrently against a stream of cold rich oil which flows direct from the 190 pound absorbers to the top of the rich oil fractionator.

Table III—Recycled Vapors, Santa Maria Valley Absorption Plant

Analysis	Rich Oil Fractionator Vapors Mol %	Raw Gasoline Accumulator Vapors Mol %
Water Vapor	0.50	0.50
Carbon Dioxide	12.60	5.80
Methane	49.64	17.50
Ethane	12.64	11.23
Propane	20.72	36.13
Iso-butane	1.40	9.38
Nor. Butane	1.93	15.75
Pentanes & Heavier	0.57	3.71
	100.00	100.00
Gallonage Content	**Gal/MCF**	**Gal/MCF**
Iso-butane	0.456	3.055
Nor. Butane	0.607	4.954
Pentanes & Heavier	0.207	1.349
Gas Rate MCF/Day	610	280
Recycled Gallonage	**Gal/Day**	**Gal/Day**
Iso-butane	278	855
Nor. Butane	370	1390
Pentanes & Heavier	126	378

Table III gives the analyses and rates of the rich oil fractionator vapor and the raw gasoline accumulator vapor. From these analyses it is computed that 86% of the methane and 71% of the ethane are removed from the system by the rich oil fractionator. The vapor from the top of the rich oil fractionator is commingled with the interstage untreated gas at 70 lbs. pressure and is compressed and recycled through the absorbers.

Can Be Converted to Pressure Still

A heater, condenser, accumulator and pumps are not required for this unit and its operation is very simple. At some future date it can be readily converted to a pressure still in order to produce propane liquid, by installing a 100-lb. condenser and accumulator. In which case, a small portion of the raw gasoline production from the low pressure stripping still would be used as reflux for the high pressure still and the remainder of the raw gasoline production from the low pressure stripping still would be circulated through the 100-lb. pressure condenser to serve as an absorbing medium for the desired propane. The stabilizer would then be fed from the 100-lb. accumulator.

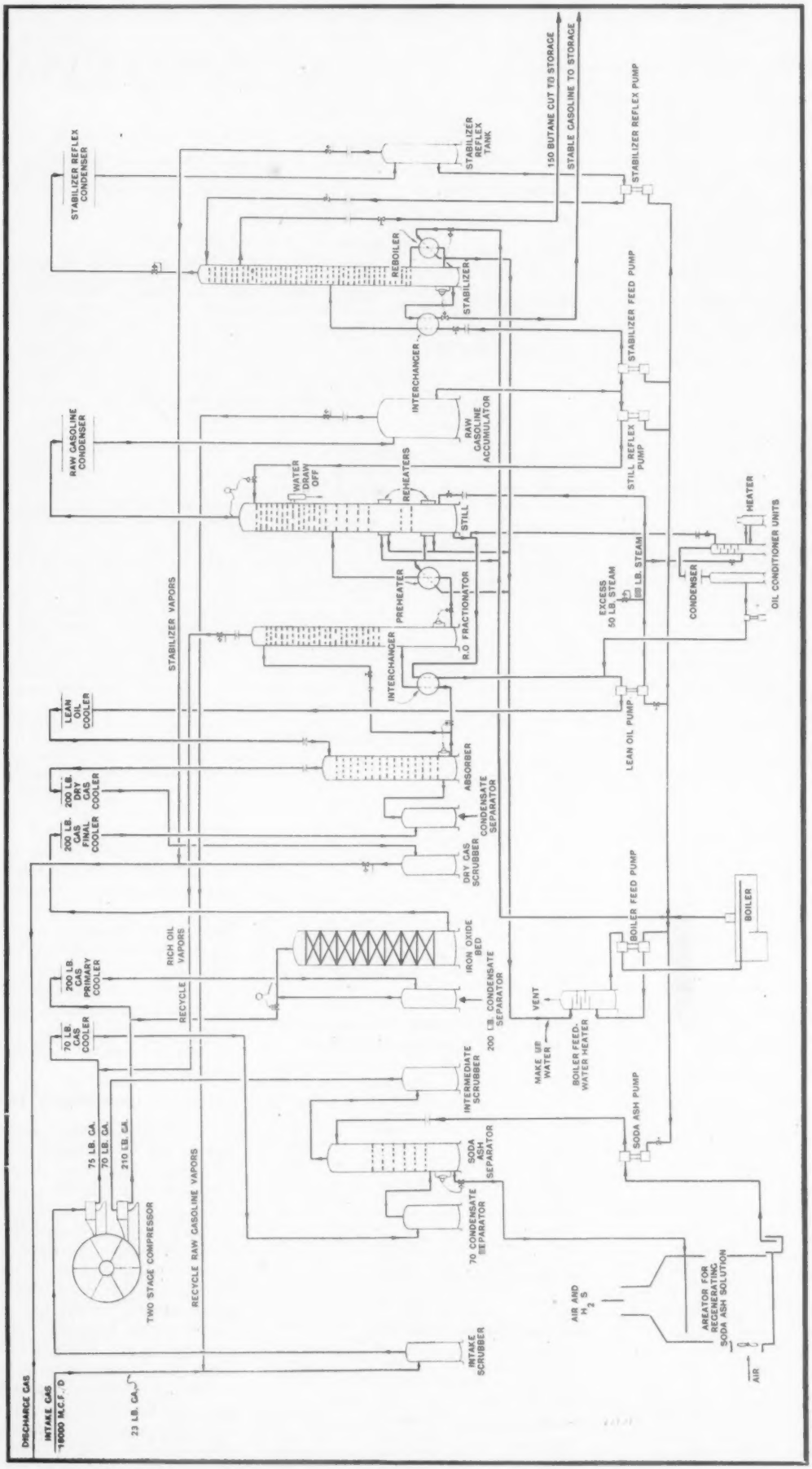
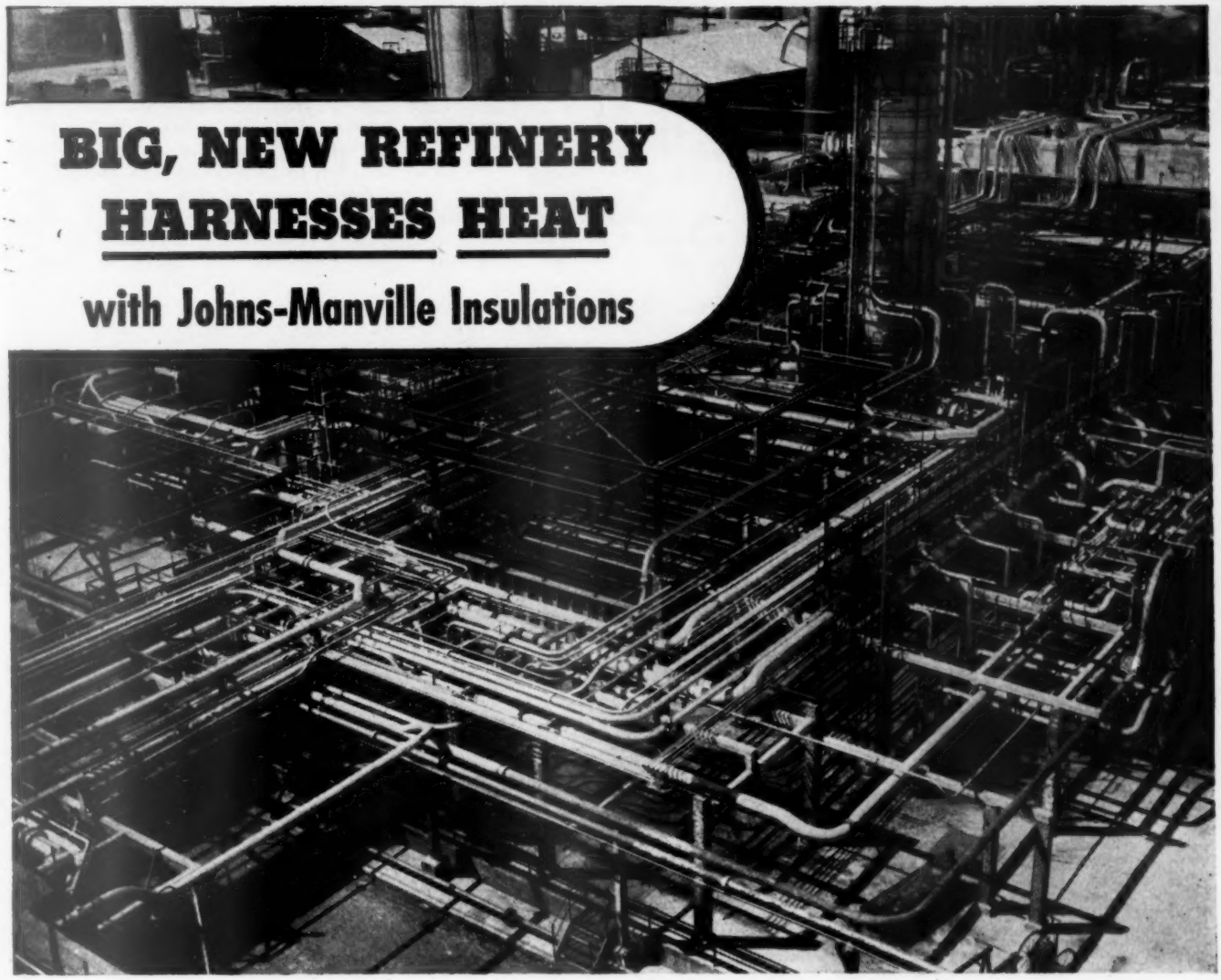


Fig. 1—Process flow diagram of the Santa Maria Valley absorption plant



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The refinery required a vast amount of insulating and refractory materials to harness and conserve the heat. The engineers selected Johns-Manville to supply these materials almost 100%. Follows a summary of the J-M materials supplied.

FURNACES—J-M Sil-O-Cel C-22 Insulating Brick and J-M-26 Insulating Firebrick

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PIPE LINES AND VESSELS FOR HEATED LIQUIDS—J-M Superex and J-M 85% Magnesia

PIPES AND VESSELS FOR COLD LIQUIDS—J-M Rock Cork

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Besides supplying practically all insulating materials, J-M also supplied other products such as asbestos rope and listing tape for packing the trays in the columns; J-M #60 Cut Service Gaskets for flanges; J-M Spirotallic for high-temperature flanges; Transite Pressure Pipe for fresh and salt water lines.

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The rich oil from the bottom of the rich oil fractionator flows through steam heated preheaters into the main stripping and fractionating still, where the raw gasoline fractions are removed from the absorption oil. The fractionating-stripping still is 60 in. in diameter and 55 ft. high. It has 19 perforated trays, 13 of which are above the feed inlet. A water drawoff tray is located immediately below the 7th tray from the top, leaving 6 trays between the feed inlet and the water drawoff tray.

Oil Reheaters Built In

The still also has built in oil reheaters located below the feed inlet. One is located between the 2nd and 3rd tray from the bottom and another is located below the bottom tray. It was realized that the heaters in this still are not ideally located, the optimum location being about two trays down from the feed. However, the cost of changing the location of the heaters would have been prohibitive and it was therefore decided to use the still "as-is". Exhaust steam at 50 lb. gauge from the lean oil pumps is metered into the bottom section of still and rises upward through the perforations of the trays in order to strip all of the raw gasoline fractions from the oil.

The still operates at 45 lbs. gauge with a bottom temperature of 350°F. and a top temperature of 170°F. The top temperature is maintained automatically by a temperature controller which regulates the amount of raw or stable gasoline used as reflux to the top of the still. The bottom section of the still provides surge capacity for the system and the level at this point varies according to the amount of oil in the system.

The hot lean oil from the bottom of the fractionating-stripping still flows through the shell side of the interchangers to the lean oil pumps which raise the pressure to 250 lbs. so that it will flow through the lean oil coolers and into the absorbers, thereby completing the oil cycle.

The raw gasoline production together with the still reflux leave the top of the still in vapor form and are then condensed in cooling units located in the cooling tower and finally are accumulated as a liquid in the raw gasoline surge tank at 40 lbs. gauge and about 65°F. The raw gasoline production is then pumped into the stabilizer at 200 lbs. where the normal butane and heavier fractions are separated from the remainder of the raw gasoline by fractionation and are produced as stabilized gasoline from the bottom of the column.

This product at Santa Maria has a Reid vapor pressure of about 30 lbs. at 100°F. The iso-butane content of the raw gasoline is required by alkylation plants in the refineries for the production of aviation gasoline. It is therefore produced as a liquid along with some normal butane and propane as a side cut from the column. This side cut liquid is withdrawn from about the sixth tray from the top of the column. It is impossible to produce a pure iso-butane in this manner because a side cut must contain at least a limited amount of all the lighter fractions which appear overhead. However, a satisfactory concentration of the desired product can often be obtained in this manner.

The removal of hydrogen sulfide from the Santa Maria gas constitutes a major problem. The hydrogen sulfide can be completely removed by means of iron oxide beds which convert the hydrogen sulfide to ferric sulfide. Then oxygen, which must be present in the gas for this process to function, converts the ferric sulfide back to iron oxide and deposits free sulfur in the bed. In actual practice the iron oxide bed consists of wood shavings impregnated with ferric oxide, thus leaving a large proportion of the bed volume void to receive the deposited sulfur. The equations for this process are as follows:

(1) $Fe_2O_3 + 3H_2S \longrightarrow Fe_2S_3 + 3H_2O$

(2) $2Fe_2S_3 + 3O_2 \longrightarrow 2Fe_2O_3 + 6S$

If the humidity and temperature of the gas are properly controlled the reactions indicated by equations (1) and (2) will continue simultaneously until the amount of deposited sulfur is great enough to prevent the hydrogen sulfide in the gas from contacting the ferric oxide. Past experience indicates that a bed will continue to function until about 20 to 25 lbs. of sulfur have been deposited per cubic foot of total bed volume. The bed must then be cleaned out and recharged. This process is very expensive in cases in which the hydrogen sulfide content of the gas is high.

Soda Ash Process Also Used

The soda ash process is commonly used where the amount of hydrogen sulfide to be removed is great. However, the soda ash process usually will not completely remove all of the hydrogen sulfide and must therefore be followed by an iron oxide bed. The soda ash process is greatly complicated by the presence of CO_2 in the gas as is indicated by the following equations.

(3) Soda Ash Na_2CO_3 + Hydrogen Sulfide $H_2S \longrightarrow$ Sodium Hydrosulfide $NaHS$ + Sodium Bicarbonate $NaHCO_3$

(4) Soda Ash Na_2CO_3 + Carbon Dioxide CO_2 + Water $H_2O \longrightarrow$ Sodium Bicarbonate $2NaHCO_3$

These reactions are reversible and according to the law of mass action a high carbon dioxide content of the gas causes a high sodium bicarbonate concentration as indicated by equation (4), moving from left to right. The high sodium bicarbonate concentration resulting from equation (4) shifts the reaction equilibrium of equation (3) from right to left, thereby reducing the removal of the hydrogen sulfide from the gas.

The soda ash units at Santa Maria were found to perform according to this theory. The 8% carbon dioxide content of the Santa Maria gas converts about 99% of the 4% soda ash solution to bicarbonate. Nevertheless with this mixture about 70% of the hydrogen sulfide is removed from the gas.

How Santa Maria's System Works

The soda ash process provided at Santa Maria consists of pumping a 4% soda ash solution to the top of two parallel 81 in. diameter contactors or absorbers, each containing 6 perforated trays. The contactors operate on the cooled compressor interstage gas at about 70 lbs. gauge, and a solution-to-gas ratio of about 35 gal. per standard MCF is employed. The solution from the bottom of the contactors flows through liquid level controllers to an areator where equation (3) is reversed by spraying the solution into a rising current of air, so as to remove the hydrogen sulfide from the field of action and discharge it from the top of the areator.

A conventional forced draft cooling tower with a 50 ft. high extended discharge stack is employed as the areator and sufficient air is blown through the areator to dilute the hydrogen sulfide to below the toxic danger limit. Equation (4) is theoretically also reversible in the areator. Practically, however, the reaction rate of equation (4) from right to left is very slow. Consequently the percentage conversion of carbonate to bicarbonate is predominately a function of the equilibrium conditions in the contactors, and very little carbon dioxide is removed from the gas after the process has been in operation a short time.

There are certain features of the processes and the construction of the Santa Maria Valley Absorption Plant which are different from an ideal plant which would be constructed if the required materials and equipment are available. For example, direct fired heat of the absorption oil is superior to steam heat. Also, absorbers with 20 or more trays instead of 15 trays are advantageous.

As pointed out earlier, nearly all of the major units were obtained by resurrecting and reconditioning idle equipment which had already seen much service. However, in spite of these limitations the fact remains that the plant was successfully constructed and put into operation under adverse conditions. And it is now adding its share of production to the war effort.

High Pressure Vapor-Liquid Equilibria

By B. W. Gamson and K. M. Watson**

(Article 5 in a Series)

A thermodynamically sound definition of the vaporization equilibrium constant is proposed and equations and charts are developed which permit its accurate calculation for any pure substance at any conditions. The vaporization equilibrium constant is related to the *vaporization ratio* y/x by the introduction of activity coefficients which take into account deviations from the laws of the ideal solution.

Generalized methods are developed for the calculation of fugacities and activity coefficients for the vapor phase and for the liquid phase of an ideal system. These calculations are tedious but may be used to develop convenient charts from which activity coefficients are read for restricted ranges of conditions. The results are not entirely satisfactory but are sufficiently accurate to be useful in ranges of extreme deviation from ideal behavior where no other general method is applicable.

IT may be demonstrated by rigorous thermodynamic methods that in any heterogeneous system which is in equilibrium under conditions of constant temperature and pressure, the fugacity f of each component must be the same in every phase in which it is present. In a system comprising components 1, 2, 3 . . . distributed between a liquid phase l and a vapor phase v,

$$(f_1)_l = (f_1)_v;\ (f_2)_l = (f_2)_v,\ etc. \quad \ldots\ldots (1)$$

Since by definition activity is the ratio of the fugacity of a component at existing conditions to its fugacity in an arbitrarily defined standard state, Equation 1 may be written in terms of activities. Thus,

$$(a_1)_l (f_1^\circ)_l = (a_1)_v (f_1^\circ)_v \quad \ldots\ldots\ldots (2)$$

where

$(a_1)_l$ and $(a_1)_v$ = the activities of component 1 in the liquid and vapor phases respectively,

$(f_1^\circ)_l$ = the fugacity of component 1 in the standard state selected for the definition of liquid phase activities,

$(f_1^\circ)_v$ = the fugacity of component 1 in the standard state selected for vapor phase activities.

Rearranging Equation 2

$$\frac{(a_1)_v}{(a_1)_l} = \frac{(f_1^\circ)_l}{(f_1^\circ)_v} = K_1 \quad \ldots\ldots\ldots (3)$$

where K_1 is the *vaporization equilibrium constant* of component 1.

It is evident that the value of the equilibrium constant is determined by the definitions of the standard states for both phases. It is convenient to choose as the standard state for the vapor phase the pure component 1 in the gaseous state at the temperature and pressure of the system. Similarly, the standard state for the liquid phase is chosen as the pure component in the liquid state at the temperature and pressure of the system. These definitions of standard states have the advantage that where the liquid and vapor approximate ideal solutions activities are equal to mole fractions. It follows from these definitions of the standard states that K_1 is a function of both the temperature and pressure of the system as well as the nature of the component.

The vaporization equilibrium constant as defined by Equation 3 provides a thermodynamically rigorous relationship between the activities of a component in vapor and liquid phases which are in equilibrium. However, before this relationship is useful it is necessary to relate activities to mole fractions through the introduction of activity coefficients. Thus, in the vapor phase

$$(a_1)_v = \phi_{v1} y_1 \quad \ldots\ldots\ldots (4)$$

where

$(a_1)_v$ = activity of component 1 in the vapor phase,

y_1 = mole fraction of component 1 in the vapor phase,

$\phi_{v1} = (f_1)_v / (f_1^\circ)_v (y_1)$ = activity coefficient of component 1 in the vapor phase.

The activity coefficient ϕ_{v1} is dependent on the properties of both component 1 and the other components with which it is mixed and also upon the temperature and pressure. Under conditions of moderate pressures and elevated temperatures gaseous solutions tend to be ideal if the components are not too widely different in properties. In such cases ϕ_v may be taken as 1.0. Maximum deviations from 1.0 occur in the region of the critical point of the solution.

In the liquid phase the relationship between activity and mole fraction is complicated by the two types of deviation from the laws of ideal solutions which were discussed by the authors[5] in the preceding paper of this series. Because of the widely different contributing causes and relationships it is convenient to consider these two types of deviation separately and assign an activity coefficient to express each. Thus,

$$(a_1)_l = \phi_{l1} \gamma_1 x_1 \quad \ldots\ldots\ldots (5)$$

where

$(a_1)_l$ = activity of component 1 in the liquid phase,

ϕ_{l1} = activity coefficient of component 1 in the liquid phase which takes into account deviations from the laws of ideal solutions resulting from differences in molecular size or volatility,

γ_1 = activity coefficient of component 1 in the liquid state which takes into account deviations from the laws of ideal solutions resulting from differences in molecular or chemical type,

x_1 = mole fraction of component 1 in the liquid phase.

For ideal systems $\gamma = 1.0$ at all conditions. For non-ideal systems γ may be determined by the methods developed by Carlson and Colburn [2] which are applicable at low pressures where the effects of differences in molecular size or volatility are small and ϕ_l may be taken as 1.0. As the temperature and pressure in such a system are increased γ tends to approach 1.0 while deviations of ϕ_l from 1.0 tend to increase.

Combining Equations 3, 4, and 5

$$\frac{y_1}{x_1} = \frac{\phi_{l1} \gamma_1}{\phi_{v1}} K_1 = K_1' \quad \ldots\ldots\ldots (6)$$

It is suggested that the ratio of the mole fractions in the vapor and liquid phases be termed the *vaporization ratio*, K_1', of component 1. It is evident from Equation 6 that the vaporization ratio is equal to the thermodynamic equilibrium constant only in ideal solutions where the activity coefficients are equal to 1.0.

Equation 6 provides a sound basis for calculations involving vapor-liquid equilibria. In many cases it is satisfactory to assume that the coefficients ϕ_{l1} and ϕ_{v1} are unity and as previously pointed out, $\gamma_1 = 1.0$ for all ideal systems. Under other conditions it is necessary to evaluate the coefficients as functions of the properties of the component and the system, either from experimental data or generalized methods of calculation.

At low temperatures and pressures

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where Dalton's law and the ideal gas law are applicable ϕ_l and ϕ_v become unity and Equation 6 reduces to

$$K_1' = \frac{y_1^*}{x_1^*} = \gamma_1 K_1 = \frac{\gamma_1 P_1^*}{\Pi^*} \quad \ldots\ldots\ldots (7)$$

Vaporization Equilibrium Constants

The definition of the standard states of unit activity which determine the value of the vaporization equilibrium constant is complicated by the fact that for a heavy component of a mixture the standard state for the vapor phase is a hypothetical state in which the pure component cannot actually exist as a gas. Similarly, for a light component the standard state for the liquid phase is a hypothetical state in which the pure component cannot actually exist as a liquid. The fugacities of the standard states under these conditions must be arrived at by arbitrary extrapolation of the fugacities of the pure components under real conditions. However, these arbitrary extrapolations in no way interfere with the fundamental validity of Equations 3 and 6. If the method of extrapolation is changed, the values of K_1 are affected but corresponding changes result in the activity coefficients so that it is only necessary that the values of ϕ_{v1}, ϕ_{l1}, γ_1, and K_1 all be referred to consistently defined standard states.

The concept of the vaporization equilibrium constant was introduced by Katz and Brown[7] who expressed it by the following equation resulting from combination of Equation 3 with the fundamental expression for the variation of fugacity with pressure.

$$K_1 = \frac{(f_1^\circ)_l}{(f_1^\circ)_v} = \frac{P_1 v_{P_1} e^{v_m(\Pi - P_1)/RT}}{\Pi v_{\Pi_1}} \quad \ldots (8)$$

where

P_1 = normal vapor pressure of comenent 1 at the temperature T of the system,

v_{P_1} = fugacity coefficient, f/p, of the vapor of component 1 at pressure P_1 and the temperature of the system,

Π = total pressure of the system,

v_m = mean molal volume of liquid component 1 between P_1 and Π at the temperature of the system,

v_{Π_1} = fugacity coefficient of component 1 in the vapor state at the temperature and pressure of the system.

The fugacity coefficient, $v = f/p$, frequently termed the activity coefficient, may be expressed as a generalized graphical function of reduced temperature and pressure [11], [17]. However, such charts can be evaluated from data on pure components only in the range of actual behavior and must be extrapolated for use in Equation 8.

As previously mentioned, this extrapolation may be arbitrary but it is desirable that it be so carried out that activities in the vapor phase are equal to mole fractions over as wide a range as possible. In the higher pressure ranges where deviations from the laws of the ideal solution become large, it is desirable that the extrapolation be such as to result in simple expressions for the activity coefficient. As a basis for the extrapolation the data of the fugacity coefficient chart of Watson and Smith[17] were plotted on logarithmic scales as shown in Fig. 1, and also with $f/p_c = vp_r$ as ordinates as shown in Fig. 2. The lines corresponding to low reduced temperatures were extrapolated on the basis of the available experimental data on the fugacities of hydrocarbons in vapor phase mixtures in the region where the vapors form approximately ideal solutions. At higher pressures the extrapolations were extended to approach the horizontal on Fig. 2. Actual fugacities of components under these conditions tend to reach a maximum with increase in pressure and then diminish as the pressure is further increased. However, for any component at a given temperature the pressure at which this maximum is reached and the variation with pressures beyond that of the maximum fugacity are entirely dependent on the composition of the mixture in which the component is present. The horizontal extrapolations of Fig. 2 are believed desirable in order to simplify the relationships between activities and

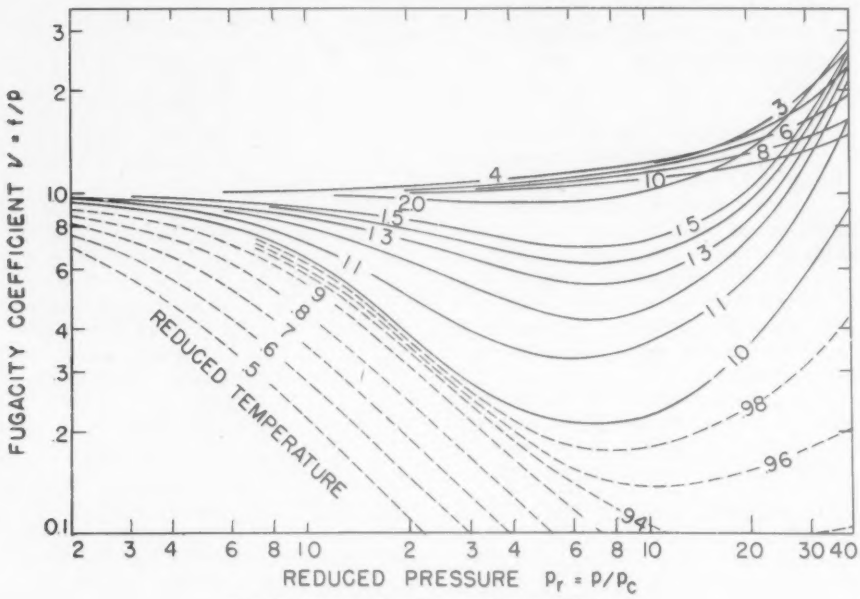

Fig. 1—Generalized fugacity coefficients

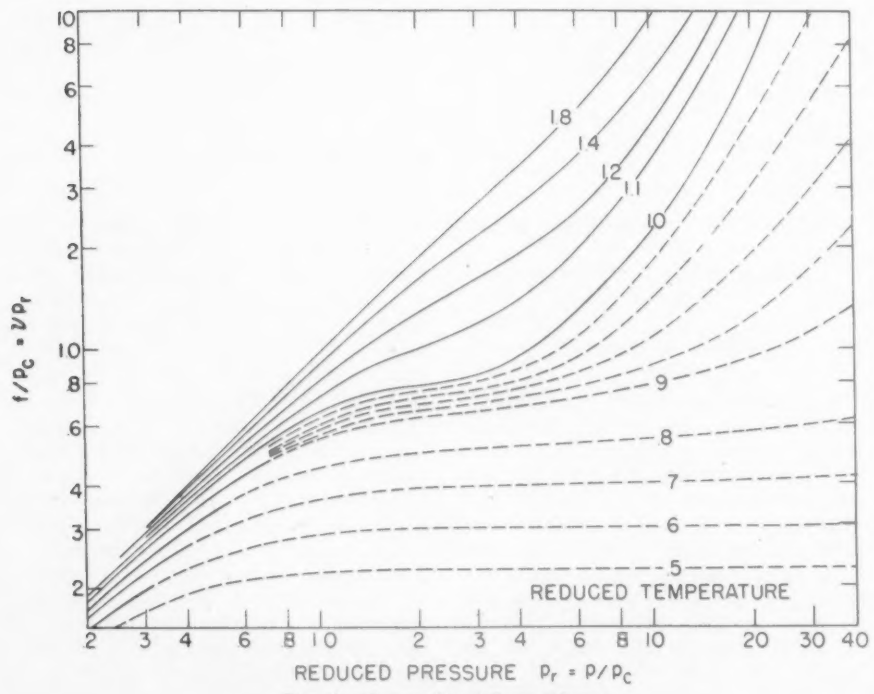

Fig. 2—Generalized fugacities

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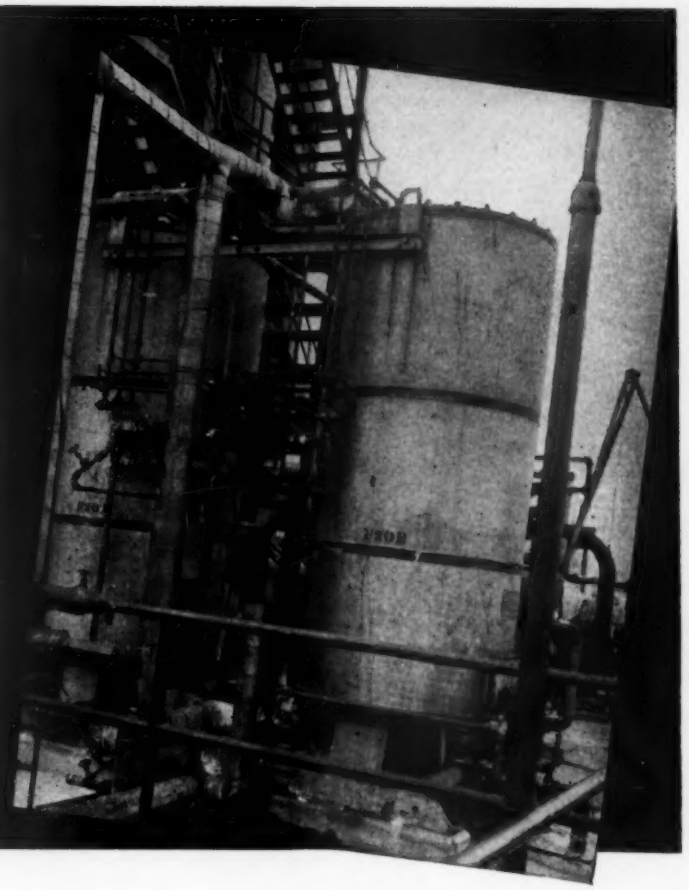

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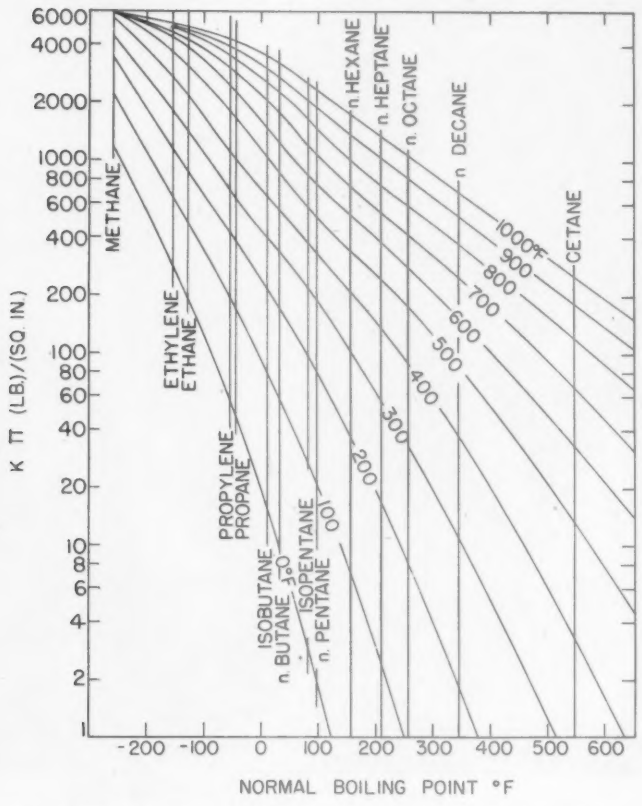

Fig. 3—Vaporization equilibrium constants of hydrocarbons at a total pressure of 100 psi.

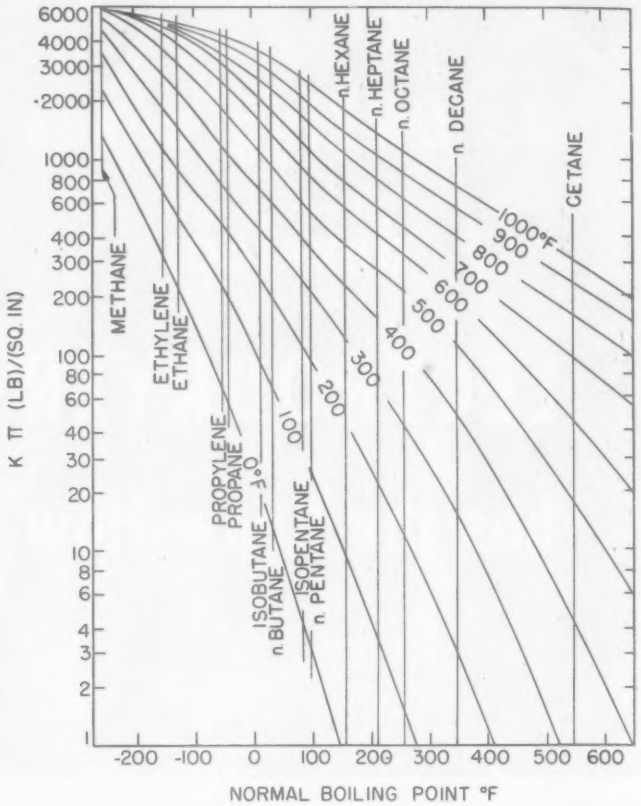

Fig. 4—Vaporization equilibrium constants of hydrocarbons at a total pressure of 200 psi.

mole fractions in this region of extreme departure from ideal solutions. The extrapolations at the higher reduced temperatures, approaching 1.0, were carried out to yield a continuous relationship between the extrapolated lines and the real values corresponding to reduced temperatures above 1.0. The broken lines on Fig. 1 are derived from those of Fig. 2 and the two charts may be used together to conveniently cover the entire range of conditions and thus define $(f_i^\circ)_v$ for any material under any conditions.

The evaluation or definition of $(f_i^\circ)_l$ in Equation 8 is complicated by uncertainty as to the proper value of v_m. At low temperatures where molal volumes are small and little affected by pressure v_m is taken as the actual molal volume of the liquid. At higher temperatures the molal volume of the liquid becomes highly dependent upon pressure, and above the critical temperature of the component has no real significance. The vapor pressure of the liquid in this region offers a further problem. Because of these uncertainties Katz and Brown calculated equilibrium constants by Equation 8 at low temperatures and pressures and then graphically extrapolated the constants into the high temperature and pressure range to conform to experimental vapor-liquid equilibrium data.

In order to more specifically define $(f_i^\circ)_l$ it is proposed that the standard state of a component in the liquid phase be taken as a hypothetical incompressible liquid whose molal volume is expressed as a function of temperature by the following equation:

$$v_m = (v_i\omega_i)(5.7+3.0T_r) \quad \ldots\ldots\ldots (9)$$

where $(v_i\omega_i)$ is the product of the molal liquid volume and the expansion factor ω[18] at any selected conditions. The term $(5.7 + 3.0\ T_r)$ corresponds to $1/\omega$ for the hypothetical incompressible liquid reference state. This value is a linear extrapolation of $1/\omega$ from the absolute zero and thus defines the liquid standard state as having a constant volumetric coefficient of expansion equal to that of the real liquid at the absolute zero. At low reduced temperatures values of v_m calculated from Equation 9 differ little from actual molal volumes. As the critical point is approached v_m is smaller than the actual molal volume except at high pressures.

The definition of $(f_i^\circ)_l$ at all conditions is completed by means of the vapor pressure equation proposed by the authors[4], which extrapolates logically above the critical point. Thus, from Equation 9 and the numerator of Equation 8,

$$\log\ (f_i^\circ)_l = \log\ P_i + \log\ v_{P_i} + \frac{(v_i\omega_i)(5.7+3.0T_r)(\Pi - P_i)}{2.303RT} \quad \ldots (10)$$

where

$$\log\ P_i = \frac{-A}{T} + B - e^{-20(T_r - b)^2} \quad \ldots (11)$$

Equations 8, 10, and 11 together with Figs. 1 and 2 completely define the fugacities of the liquid and vapor reference states and the equilibrium constant in an arbitrary but logical manner which is definite, reproducible and applicable to any material at any conditions.

From these relationships charts may be developed which express the vaporization equilibrium constant of a specific compound as a function of temperature and pressure. Series of such charts have been developed by several investigators for many of the lower-boiling hydrocarbons. An alternate method of graphical presentation which is convenient when working with mixtures of homologs of a single series is to restrict each chart to a constant pressure and plot curves each of which expresses the equilibrium constant of a particular compound as a function of temperature at the pressure of the chart. With this scheme a series of charts each corresponding to a different pressure is required.

Another method for presenting equilibrium constant data for an homologous series is shown in Figs. 3 and 4 for the paraffin hydrocarbons. These charts were calculated by Equations 8 and 10 from the vapor pressure and density data developed by the authors[4]. Although based on the data for paraffins they may be used for olefins with little error. The products of $K\Pi$ in pounds per square inch are plotted as ordinates with the normal boiling points of the homologs as abscissas. Each curve on the chart

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corresponds to a constant temperature and the chart is restricted to a constant total pressure Π. It will be noted that for the low boiling compounds there is little difference between the values of $K\Pi$ at 100 and 200 pounds per square inch from Figs. 3 and 4 respectively. For such compounds in the moderate pressure range the problem of interpolating between charts to obtain values of K at some intermediate pressure is simplified by plotting $K\Pi$ rather than K. In the high pressure range or for high boiling compounds $K\Pi$ varies with pressure more than K and it is preferable to plot K directly. The choice of the method of plotting is a matter of convenience dependent upon the type of problem.

If it is assumed that ideal solutions are formed and that all activity coefficients are unity, equilibrium constants calculated from Equations 8 and 10 may be used directly for vaporization calculations as outlined by Katz and Brown[7]. This assumption that vaporization ratios are equal to vaporization equilibrium constants leads to serious errors in the vicinity of the critical points of the mixture or when calculating the equilibrium distribution of a component whose properties are widely different from the average properties of the mixture, as for example when methane is dissolved in absorber oil. In such cases the activity coefficients of Equation 6 must be evaluated for reliable results.

In general, equilibrium constants calculated from Equations 8 and 10 and Figs. 1 and 2 are intermediate between the values from the charts developed by Brown and co-workers and those from the charts based on the work of Lewis and co-workers[12], [16]. The differences between these two widely used sets of equilibrium constant charts has resulted in much confusion especially in evaluating plate efficiencies in high pressure, fractionating columns. When these constants are used without the introduction of activity coefficients, data on specific types of mixtures can be cited to prove the superiority of either set.

Equilibrium constants calculated from Equations 8 and 10 are recommended in preference to either of the currently used sets of charts for the following reasons:

(1) The constants are accurately defined in a thermodynamically sound manner by means of general charts and equations which are applicable to all types of materials at all conditions.

(2) It is believed that the *average* deviation from unity of the activity coefficients or correction factors required by the formation of non-ideal solutions is less than when either of the currently accepted sets of charts is used. This does not mean that for certain specific non-ideal mixtures either of the other values may not be superior.

(3) The fundamental definition of the equilibrium constant by Equations 8 and 10 and Figs. 1 and 2 results in regular and consistent variations of the individual standard fugacities for the two phases. Such relationships are necessary for the development of a useful correlation of activity coefficients which will permit rigorous vaporization calculations.

Activity Coefficients

The evaluation of the activity coefficient γ in non-ideal systems at low pressures has been ably developed by Carlson and Colburn[2]. Before these methods can be extended to high pressures it is desirable to evaluate the activity coefficients ϕ_l and ϕ_v. It is also possible that there may be a significant deviation from ideal behavior in the gas phase at high pressures which is due to chemical dissimilarity and should be represented by a fourth activity coefficient γ_v. However, it is hoped that this coefficient ordinarily may be neglected.

In ideal systems, where $\gamma = 1.0$ at all conditions, from Equations 4 and 5

$$\phi_{vi} = \frac{f_{vi}}{y_i (f_i^\circ)_v} \quad \ldots\ldots (12)$$

$$\phi_{li} = \frac{f_{li}}{x_i (f_i^\circ)_l} \quad \ldots\ldots (13)$$

Since the fugacities of the standard states are completely defined by Equations 8 and 10 and Figs. 1 and 2, it is possible to calculate activity coefficients from Equations 12 and 13 if the fugacities of the components at the conditions of the solutions can be evaluated.

It is evident that ability to evaluate the fugacities of the components of the liquid and vapor phases will permit direct calculation of vapor-liquid equilibrium conditions from Equation 1 without the introduction of the activity or equilibrium constant concepts. However, because of the extremely complex relationships between fugacities and the controlling variables, such calculations appear to be hopelessly tedious for any direct practical application. It is believed that the procedure involving equilibrium constants which are corrected by coefficients derived from generalized fugacity relationships will prove much more useful. Activity coefficients can be correlated in charts for specific systems and ranges of conditions and applied as correction factors without undue complication of the trial and error procedures usually required for equilibrium calculations.

Fugacities in Gaseous Mixtures

Since by definition[10] the fugacity of a gas is equal to its pressure where conditions are such that the ideal gas law is obeyed, it follows that the fugacity of a component in a gaseous mixture may be evaluated from compressibility data by integration of the following thermodynamically rigorous relationship.

$$\left(\frac{\partial \ln f_i}{\partial p}\right)_{Tn} = \frac{\overline{v}_i}{RT} \quad \ldots\ldots (14)$$

where

f_i = fugacity of component i

$\overline{v}_i$ = partial molal volume of component i

n = indicates constancy of composition

On the basis of the pseudo critical concept and the generalized compressibility relationships the authors[5] developed a method for calculating partial molal volumes in gaseous mixtures. Combining this equation with Equation 14 yields a generalized expression for fugacities. Thus, at constant temperature and composition,

$$d \ln f_i = \frac{z'}{p_r'} dp_r' + T_r' \left(1 - \frac{T_{ci}}{T_c'}\right) \times \left(\frac{T_{ci}}{T_c'}\right)^{.6} \left(\frac{\partial z'}{\partial T_r'}\right)_{p_r'} d \ln p_r' + \left(1 - \frac{p_{ci}}{p_c'}\right) \left(\frac{p_{ci}}{p_c'}\right)^{.6} \left(\frac{\partial z'}{\partial p_r'}\right)_{T_r'} dp_r' \quad \ldots\ldots (15)$$

By subtracting $d \ln \Pi$ from each side of Equation 15 and noting that

$$\left(\frac{\partial z'}{\partial p_r'}\right)_{T_r'} dp_r' = dz'$$

$$d \ln \frac{f_i}{\Pi} = (z'-1) d \ln \Pi + T_r' \left(1 - \frac{T_{ci}}{T_c'}\right) \times \left(\frac{T_{ci}}{T_c'}\right)^{.6} \left(\frac{\partial z'}{\partial T_r'}\right)_{p_r'} d \ln p_r' + \left(1 - \frac{p_{ci}}{p_c'}\right) \left(\frac{p_{ci}}{p_c'}\right)^{.6} dz' \quad \ldots\ldots (16)$$

It may be shown[17] that $(z'-1)\, d \ln \Pi = d \ln (f'/\Pi)$ where f' may be termed the pseudo fugacity of the mixture as a whole and f'/Π its pseudo fugacity coefficient, which may be read from Figs. 1 or 2 as a function of pseudo reduced temperature and pressure. With this substitution Equation 16 may be integrated between the pressure limits of Π and Π°, a low pressure at which the mixture follows the ideal gas law. At the conditions of the lower limit $z' = 1.0$, $f'/\Pi = 1.0$ and $f_i = y_i \Pi$. Thus,

$$\ln \frac{f_i}{y_i \Pi} = \ln \frac{f'}{\Pi} + T_r' \left(1 - \frac{T_{ci}}{T_c'}\right) \left(\frac{T_{ci}}{T_c'}\right)^{.6} \times \int_{\Pi^\circ}^{\Pi} \left(\frac{\partial z'}{\partial T_r'}\right)_{p_r'} d \ln p_r' + (z'-1) \left(1 - \frac{p_{ci}}{p_c'}\right) \left(\frac{p_{ci}}{p_c'}\right)^{.6} \quad \ldots\ldots (17)$$

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It may be shown that the pseudo fugacity f' is related to the fugacities of the individual components by the expression

$$\ln f' = \Sigma N_i \ln\left(\frac{f_i}{N_i}\right)$$

or

$$f' = \Pi\left(\frac{f_i}{N_i}\right)^{N_i}$$

A generalized chart of

$$\int_{\Pi^*}^{\Pi}\left(\frac{\partial z'}{\partial T_r'}\right)_{p_r'} d\ln p_r'$$

was prepared by evaluating

$$\left(\frac{\partial z'}{\partial T_r'}\right)_{p_r'} \frac{1}{p_r'}$$

from a cross plot of z' on rectangular coordinates. These derivatives were plotted at constant temperature against p_r' and the integral evaluated as the areas under the curves. The resulting values are plotted as a function of pseudo reduced temperature and pressure in Fig. 5. It may be shown that this integral is related to the generalized enthalpy correction for gases due to lack of ideal behavior by the following equation:

$$\int_{\Pi^*}^{\Pi}\left(\frac{\partial z'}{\partial T_r'}\right)_{p_r'} d\ln p_r' = \left(\frac{H^*-H}{T_c'}\right)' \frac{1}{R(T_r')^2} \qquad (18)$$

However, an exact correspondence between the best average forms of the two generalized charts does not exist due to the lack of perfect correlation using the theory of corresponding states.

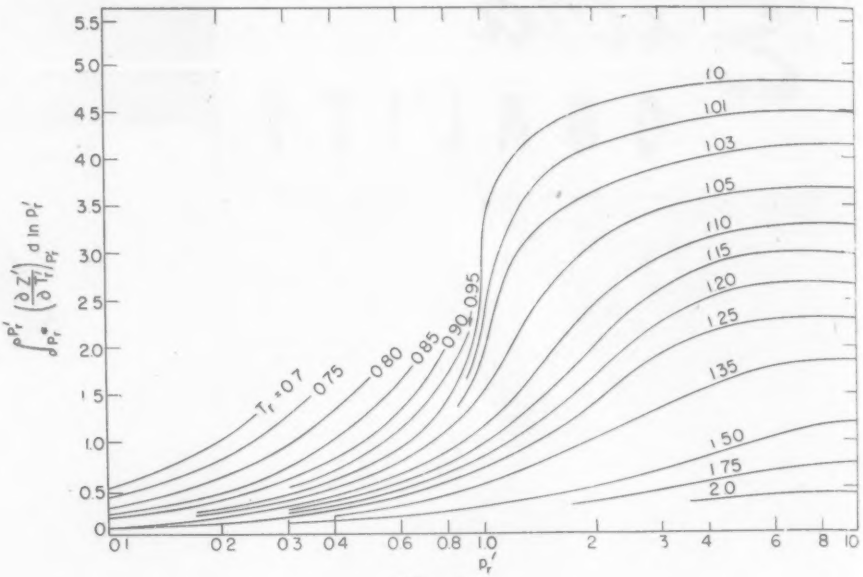


Fig. 5

Fig. 5 together with Figs. 1 and 2 for the evaluation of f'/Π and the generalized z chart permits direct evaluation from Equation 17 of the fugacity of a component in any gaseous mixture.

The results are not exact because of the inherent inaccuracies of generalized correlations based on the theorem of corresponding states and because of the lack of a satisfactory expression for calculating pseudo critical properties. At low pressures, as ideal behavior is approached, fugacities calculated from Equation 17 are frequently less accurate than those obtained by assuming that ideal solutions are formed. For this reason, Equation 17 is best used to calculate activity coefficients at high pressures from Equation 12. The resulting relationships are then graphically extended to low pressures in such a manner that the activity coefficients become asymptotic to 1.0 as the range of ideal behavior is approached.

In Table I are fugacities calculated from Equation 17 compared to values from the literature based on direct experimental data for the methane—ethane and methane—*n*-butane systems. It will be noted that the agreement is reasonably good, even under highly non ideal conditions, with errors generally less than 15%.

TABLE I—Calculated and Experimental Values of $f/y\Pi$ for Gaseous Mixtures

Mole Fraction, C_1	Temp., °K	Π lb./sq. in.	—Experimental— $f_1/y_1\Pi$	$f_2/y_2\Pi$	Calculated (Eq. 17) $f_1/y_1\Pi$	$f_2/y_2\Pi$
Methane—Ethane[14]						
.8823	294.3	3500	.708	.239	.749	.208
.8823	294.3	250	.968	.889	.973	.850
.8823	344.3	3500	.836	.399	.875	.380
.8823	394.3	3500	.914	.548	.965	.509
Methane—*n*-Butane[15]						
.9355	294.3	500	.945	.482	.940	.433
.9702	294.3	500	.941	.519	.941	.512
.9702	294.3	2000	.798	.118	.799	.112
.2870	344.3	180	1.00	.775	1.04	.789
.2870	361.0	261	1.01	.721	1.07	.734
.2870	394.3	521	1.08	.580	1.11	.593
1.0	294.3	500	.939	.548	.950	.547
1.0	294.3	3000	.738	.063	.750	.063
1.0	394.3	3000	.932	.217	.954	.245
1.0	344.3	3000	.859	.113	.870	.123
.9702	294.3	1000	.887	.295	.896	.290
.9702	294.3	3000	.739	.063	.754	.058
.9702	344.3	3000	.856	.135	.875	.137
.9702	394.3	3000	.930	.246	.965	.238
.475	344.3	259	1.00	.694	1.04	.709
.475	361	389.5	1.02	.614	1.06	.636
.475	377.7	590	1.07	.517	1.09	.529
.475	394.3	500	1.03	.613	1.08	.636
.475	394.3	3000	1.16	.149	1.19	.149

Fugacities in Liquid Solutions of Ideal Systems

Equation 14 might be used to calculate the fugacity of a component in a liquid solution, if a reference fugacity at some pressure and the same temperature were known. In order to be practical this would require the assumption that at some pressure the liquid solution behaves ideally. This obviously would not be valid at many temperatures.

In a previous paper[5], the authors pointed out that ideal systems at low pseudo-reduced temperatures, where the saturated vapor of each component behaves as an ideal gas, form ideal solutions. This provides a convenient means for establishing the fugacity of a component under non-ideal conditions in an ideal liquid system by a temperature integration at constant pressure.

The change in fugacity with temperature of a component in a liquid system may be calculated directly from partial molal enthalpy data by means of the rigorous thermodynamic relationship.

$$\left(\frac{\partial \ln f_i}{\partial T}\right)_{pn} = \frac{H_i^* - \overline{H}_i}{RT^2} \qquad (19)$$

The term $H_i^* - \overline{H}_i$ may be estimated from the generalized expressions derived by the authors in an earlier paper[5] on the basis of the pseudo-critical concept. Substituting this generalized relationship in Equation 19, converting to reduced units and integrating from the lower limit of $T_r' = .1$,

$$\ln\frac{f_{i2}}{f_{i1}}$$

$$=\frac{\lambda_{io}}{RT_c'}\int_{.1}^{T_r'_2}\frac{(1-T_r')^{.38}}{(T_r')^2}dT_r'+\frac{.38\lambda_o'}{RT_c'}\left(\frac{T_{ci}}{T_c'}-1\right)\left(\frac{T_{ci}}{T_c'}\right)^{.6}\int_{.1}^{T_r'_2}\frac{dT_r'}{T_r'(1-T_r')^{.62}}+$$

$$\frac{1}{R}\int_{.1}^{T_r'_2}\frac{\left(\frac{H^*-H_s}{T}\right)}{T_r'}dT_r'+\frac{\left(1-\frac{T_{ci}}{T_c'}\right)\left(\frac{T_{ci}}{T_c'}\right)^{.6}}{R}\int_{.1}^{T_r'_2}d\left(\frac{H^*-H_s}{T}\right)'+$$

$$\frac{p_c'(v_1\omega_1)_i+p_c'\left(\frac{p_{ci}}{p_c'}-1\right)\left(\frac{p_{ci}}{p_c'}\right)^{.6}(v_1\omega_1)'}{RT_c'}\int_{.1}^{T_r'_2}\frac{(\psi_l-\psi_s)'}{(T_r')^2}dT_r'+$$

$$\frac{p_c'(v_1\omega_1)'\left(1-\frac{T_{ci}}{T_c'}\right)\left(\frac{T_{ci}}{T_c'}\right)^{.6}}{RT_c'}\int_{.1}^{T_r'_2}\frac{d(\psi_l-\psi_s)'}{T_r'}+$$

$$\frac{\Pi(v_1\omega_1)'\left(1-\frac{p_{ci}}{p_c'}\right)\left(\frac{p_{ci}}{p_c'}\right)^{.6}}{RT_c'}\int_{.1}^{T_r'_2}\left(\frac{\partial(\psi_l-\psi_s)'}{\partial p_r'}\right)_{T_r'}\frac{dT_r'}{(T_r')^2}\quad\ldots\ldots\ldots\ldots(20)$$

Equation 20 may be used to calculate the fugacity of any component in an ideal liquid system provided its fugacity at the temperature corresponding to $T_r' = .1$ is available. At this low pseudo reduced temperature it may be assumed that all ideal systems form ideal solutions in which the fugacity of each component is proportional to its mole fraction.

The procedure in using Equation 20 is as follows: For each of the components the vapor pressure at the temperature corresponding to the pseudo reduced temperature of .1 is calculated by the following low range vapor pressure equation which was developed by the authors in an earlier paper [4]:

$$\ln\frac{p_2}{p_1}=\frac{\lambda_o}{RT_c}\int_{.1}^{T_{r_2}}\frac{(1-T_r)^{.38}}{T_r^2}dT_r\ldots(21)$$

The fugacity of each pure component at this temperature and the total pressure of the system is obtained from the following fundamental thermodynamic expression for the effect of pressure on fugacity, assuming that the liquids are incompressible at the low temperatures involved:

$$\ln\frac{(f_i)_\Pi}{(f_i)_{Pi}}$$

$$=\frac{v}{RT}(\Pi-P_i)$$

$$=\frac{(v_1\omega_1)_i}{\omega RT}(\Pi-P_i)\quad\ldots\ldots\ldots\ldots(22)$$

where $(f_i)_\Pi$ is the fugacity of pure component i at the total pressure Π and $(f_i)_{Pi}$ is its fugacity at its vapor pressure.

The components are then mixed under isothermal and isobaric conditions and the fugacity of each in the solution becomes equal to the fugacity of the pure substance times its mole fraction. This value is f_{i1} corresponding to the lower limit in Equation 20. The fugacity f_{i2} at any temperature below the pseudo critical is obtained by carrying out the indicated integration at constant pressure and composition. The integrals of Equation 20 have been evaluated in terms of pseudo reduced conditions and are summarized in Figs. 6 through 11. This expression can be used only at pseudo-critical temperatures of 1.0 or less.

A fundamental test which must be met by Equation 20 is that it shall be applicable to pure components. In this case $T_{ci}/T_c' = 1.0$ and $p_{ci}/p_c' = 1.0$ and the equation reduces to,

$$\ln\frac{f_2}{f_1}$$

$$=\frac{\lambda_o}{RT_c}\int_{.1}^{T_{r_2}}\frac{(1-T_r)^{.38}}{T_r^2}dT_r+$$

$$\frac{1}{R}\int_{.1}^{T_{r_2}}\frac{\left(\frac{H^*-H_s}{T}\right)}{T_r}dT_r+$$

$$\frac{p_c(v_1\omega_1)}{RT_c}\int_{.1}^{T_{r_2}}\frac{\psi_l-\psi_s}{T_r^2}dT_r\quad\ldots.(23)$$

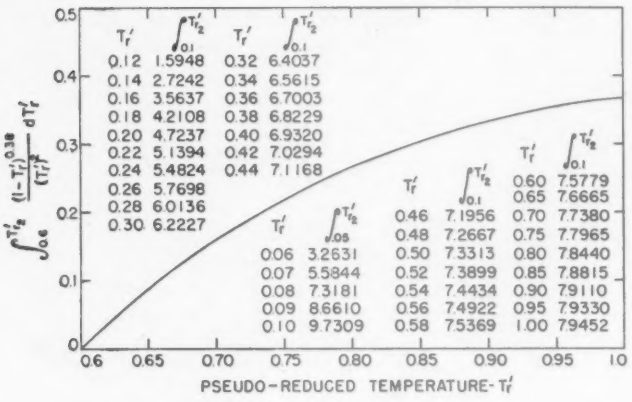
This expression was corroborated by calculating fugacities of the saturated liquid for various substances from the reference reduced temperature to the critical temperature. The procedure followed was to evaluate the vapor pressure at a reduced temperature of .1 from Equation 21 using a reference vapor pressure near 10 mm Hg as recommended by the authors in a previous article[4]. At such low vapor pressures, the fugacity becomes equal to the pressure. The fugacity at $T_r = .1$ and the pressure of the system is then obtained from Equation 22. This fugacity is used as the lower limit in Equation 23 and the fugacity at the temperature of the system obtained. Table II compares fugacities calculated in this manner for pure substances with fugacities obtained from Figs. 1 or 2 and vapor pressures interpolated from experimental measurements.

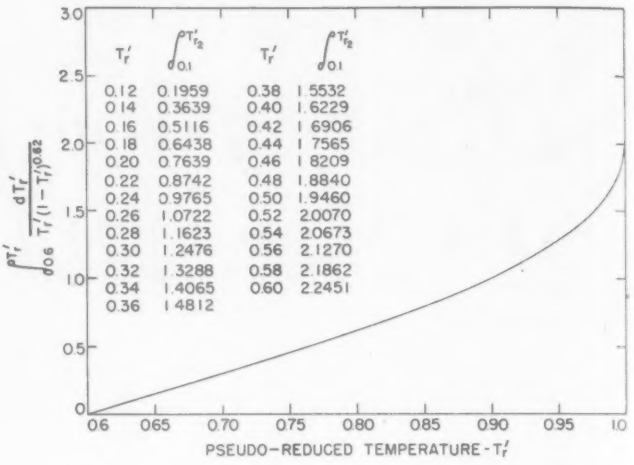
The fugacities of components in a liquid solution at temperatures above its pseudo critical temperature may be calculated by first evaluating the fugacities at the pseudo critical temperature and the pressure of the system, by means of Equation 20. The integration of Equation 19 is then carried on to higher temperatures by treating the liquid at pseudo reduced temperatures greater than 1.0 as a compressed gas. In an earlier paper[5] the authors developed a generalized equation for partial molal enthalpies in

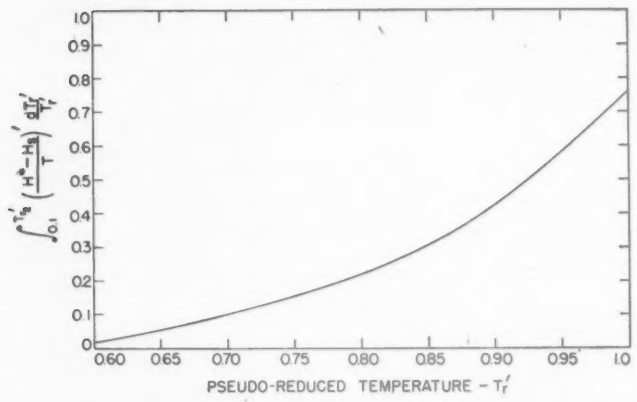
TABLE II—Fugacities of Saturated Vapors of Pure Compounds

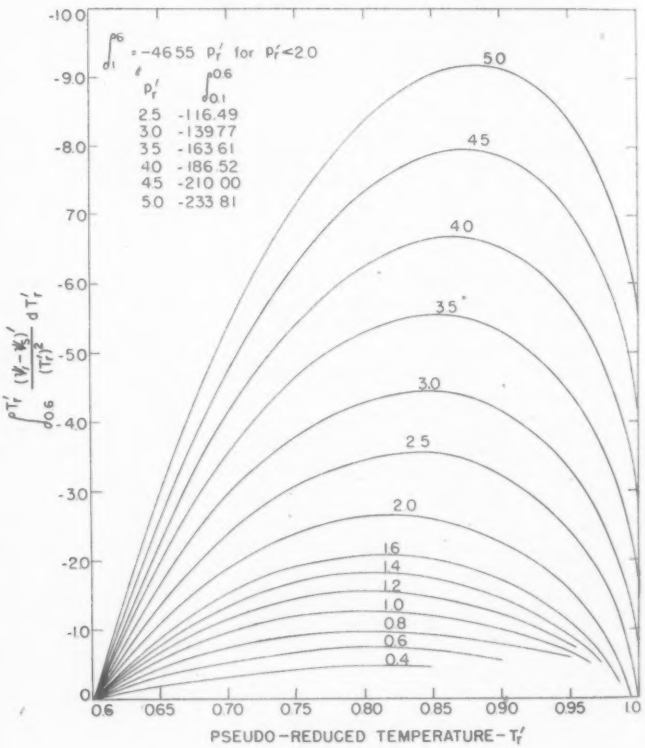
	Ethane	n-Butane	n-Heptane
λ, cal/g-mole at T_λ	3515[3]	5366[3]	7625[6]
T_λ, °C.	−88.9	−.55	98.42
Vapor pressure, P_1 at T_p, mm. (for Eq. 21)	18.62	36.26	20.50
T_p, °K	135.7	212.7	283.2
Vapor Pressure, T_r=.1 (from Eq. 21), mm.	6.31×10^{-25}	1.32×10^{-25}	6.40×10^{-33}

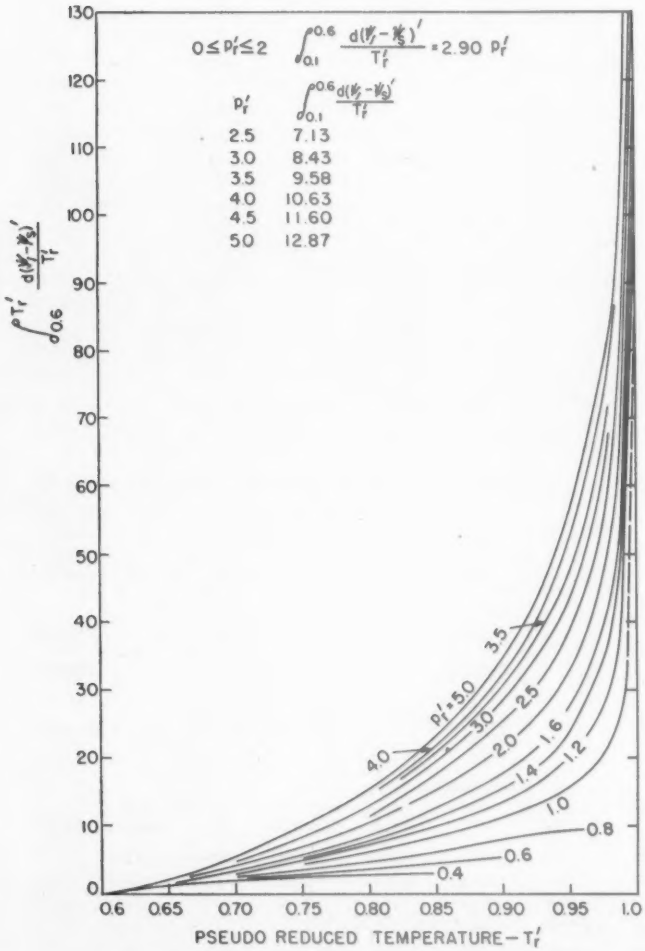
	Fugacities—mm Hg								
	C_2			n-C_4			n-C_7		
T_r	P_r	Expt.[6]	Eq.(23)	P_r	Expt.	Eq.(23)	P_r	Expt.	Eq.(23)
.75	.138	4,560	4,740	.1170	3,030	2,950	.088	1,720	1,750
.80	.227	7,069	7,320	.2003	4,900	4,790	.162	2,960	3,080
.85	.351	10,410	10,600	.3215	7,460	7,210	.277	4,755	4,960
.90	.517	14,560	14,770	.4896	10,730	10,300	.446	7,200	7,480
.95	.731	19,240	19,880	.7128	14,600	14,200	.681	10,180	10,670
1.00	1.0	24,370	25,600	1.0	18,700	18,420	1.0	13,400	14,200

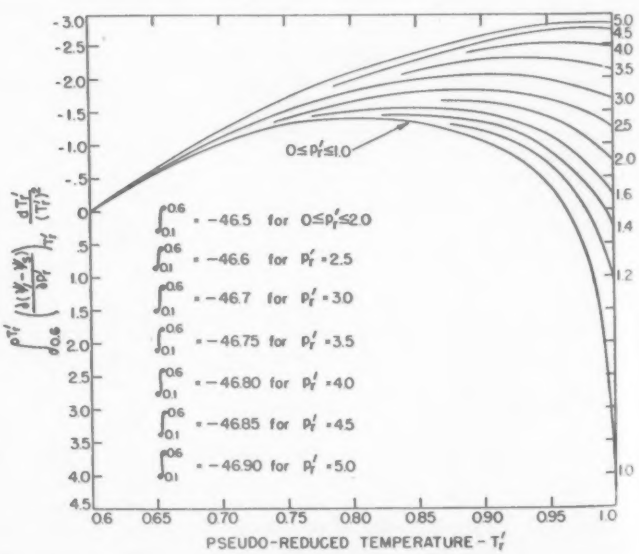











$\int_{0.6}^{T_f'} \left(\frac{\partial(\Psi-\Psi_0)'}{\partial p_f'}\right)_{T_f'} \frac{dT_f'}{(T_f')^2}$
$0 \le p_f' \le 1.0$
$\int_{0.1}^{0.6}$ = −46.5 for $0 \le p_f' \le 2.0$
$\int_{0.1}^{0.6}$ = −46.6 for p_f' = 2.5
$\int_{0.1}^{0.6}$ = −46.7 for p_f' = 3.0
$\int_{0.1}^{0.6}$ = −46.75 for p_f' = 3.5
$\int_{0.1}^{0.6}$ = −46.80 for p_f' = 4.0
$\int_{0.1}^{0.6}$ = −46.85 for p_f' = 4.5
$\int_{0.1}^{0.6}$ = −46.90 for p_f' = 5.0
PSEUDO-REDUCED TEMPERATURE-T_f'

Figs. 6 through 11—Integrals of Equation 20, evaluated in terms of pseudo reduced conditions

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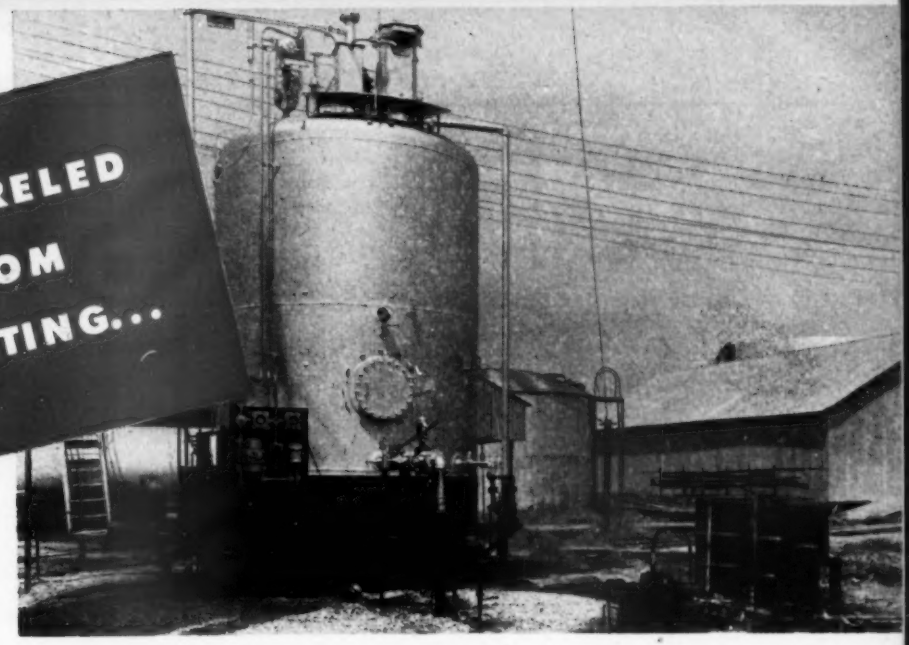

AN Oklahoma refinery was experiencing severe corrosion caused by salts in the crude charge. Sometime after the Petreco installation, the refinery management noted that since the desalting process had been used, the average tetraethyl consumption was considerably less than it had been previously. Records were carefully checked, and they showed that in the blending of one gasoline, *a saving of approximately .4 c.c. lead per gallon had been effected.*

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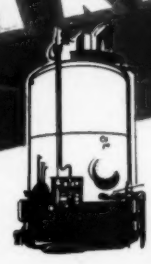

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gaseous systems. Combining this expression with Equation 19 and integrating at constant pressure and composition with $T_r' = 1.0$ as the lower limit,

$$R \ln \frac{f_2}{f_1} = \int_{1.0}^{T_{r'_2}} \frac{\left(\frac{H^*-H}{T}\right)'}{T_r'} dT_r' + \left(1 - \frac{T_{ci}}{T_c'}\right)\left(\frac{T_{ci}}{T_c'}\right)^{.6} \times \left[\left(\frac{H^*-H}{T}\right)'_{T_r' p_r'} - \left(\frac{H^*-H}{T}\right)'_{T_r'=1.0}\right] + p_r'\left(1 - \frac{p_{ci}}{p_c'}\right)\left(\frac{p_{ci}}{p_c'}\right)^{.6} \times \int_{1.0}^{T_{r'_2}} \left[\frac{\partial\left(\frac{H^*-H}{T}\right)'}{\partial p_r'}\right]_{T_r'} \frac{dT_r'}{T_r'} \quad \ldots\ldots\ldots\ldots\ldots\ldots (24)$$

where f_1 is the fugacity at the pressure of the system and the pseudo critical temperature calculated from Equation 20.

The integrals of Equation 24 have been evaluated and are plotted in Figs. 12 and 13 as functions of pseudo reduced conditions.

As previously pointed out, when a vapor and liquid phase are in equilibrium, the fugacity of a given substance must be the same in each phase. The consistency of Equations 17, 20 and 23 may be verified by calculating fugacities for both the gas and liquid phases for systems whose compositions at equilibrium have been experimentally determined. Kay[9] has studied the vapor liquid equilibrium of binary mixtures of ethane, butane and heptane. The fugacities were calculated in both the liquid and vapor phases for equilibrium mixtures of various compositions at conditions varying from relatively low temperatures and pressures to the true critical temperature and pressure of some mixtures. These results are tabulated in Table III. It will be noted that for these systems good agreement between the calculated fugacities is obtained, even in the region of the true critical point where maximum deviations from ideal behavior are encountered.

Similar comparisons made from the data on methane—decane equilibria of Reamer, Olds, Sage and Lacey[13] yielded much less satisfactory agreement with discrepancies greater than 50% in some cases. It may be concluded that the generalized methods of calculating fugacities in both the liquid and gaseous phases are sufficiently accurate for many types of engineering calculations where large differences in volatility are not involved. Thus, agreement is good for the ethane—heptane system where the maximum ratio of T_{ci}/T_c' is 2.0 but poor for the methane—decane system where T_{ci}/T_c' may be as great as 3.25.

Utility of Methods

The vaporization equilibrium constants calculated from Figs. 1 and 2 and Equations 8 and 10 may be applied without correction to vaporization calculations where it may be assumed that ideal solutions are formed. As previously pointed out it is believed that equilibrium constants defined in this manner possess significant advantages as compared to those derived by empirical extrapolation of the equilibrium constants themselves.

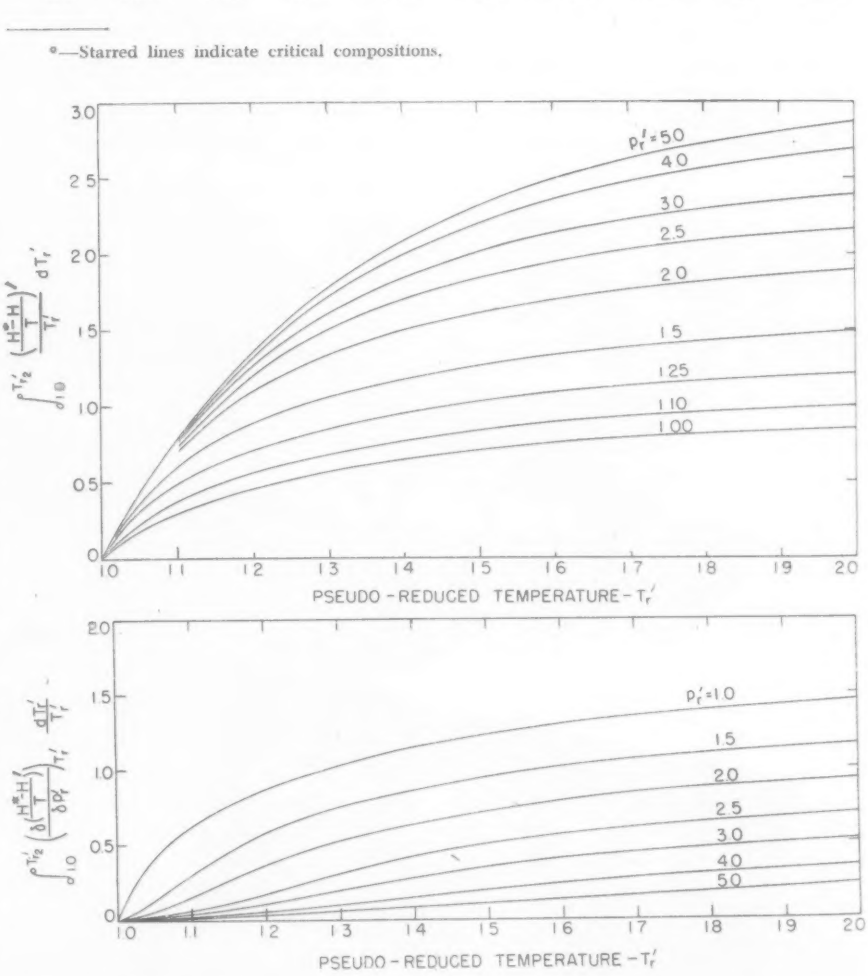
The distinction which is developed between the vaporization equilibrium constant and the vaporization ratio leads to the possibility of accurate vaporization calculations even where large deviations from the laws of ideal solutions are encountered. The introduction of the three activity coefficients ϕ_v, ϕ_l and γ represents a thermodynamically sound ap-

TABLE III—Fugacities of Vapor-Liquid Equilibrium Systems

Ethane—*n*-Heptane[8]

Pressure lbs./sq. in.	Temp. ° F.	Vapor Comp. C_2	Vapor Comp. C_7	Liquid Comp. C_2	Liquid Comp. C_7	Calc. fugacities, lb./sq in. —Vapor— C_2	—Vapor— C_7	—Liq.— C_2	—Liq.— C_7
850	120.3	.9685	.0315	.9685	.0315	551	0.66	576	0.58*
100	232.2	.7709	.2291	.064	.936	76.7	19.2	76.6	19.2
200	275.0	.7709	.2291	.123	.877	152	34.5	159	33.4
600	341.9	.7709	.2291	.295	.705	436	65.0	466	73.3
800	350.2	.7709	.2291	.370	.630	579	67.5	492	67.4
1250	303.5	.7709	.2291	.705	.295	837	40.7	853	45.7
682	468.2	.2654	.7346	.2654	.7346	283	202	255	212 *
1106	373.9	.5871	.4129	.5871	.4129	683	97	711	106 *
		***n*-Butane and *n*-Heptane[9]**							
		C_4	C_7	C_4	C_7	C_4	C_7	C_4	C_7
596	458.8	.801	.199	.801	.199	367	33.4	356	29.0 *
452	492.1	.159	.841	.159	.841	91.6	220	80	220 *
538	448.9	.425	.575	.425	.575	234	130	208	133 *

*—Starred lines indicate critical compositions.



Figs. 12 (top) and 13—Integrals of Equation 24, evaluated as functions of pseudo reduced conditions

Coming Articles in Process Engineering Series

"A Universal Viscosity Correlation," by O. A. Uyehara and K. M. Watson, will be the next and sixth in this series of articles dealing with the development of fundamental physical chemistry data. It will appear in the Oct. 4 issue.

The paper will present methods for the prediction of viscosity in the liquid or gaseous state at any single-phase conditions of temperature and pressure for both pure substances and mixtures.

Appearing exclusively in the Technical Section of NATIONAL PETROLEUM NEWS, this series presents data which are the results of studies being conducted at the University of Wisconsin as part of a graduate reseach program in chemical engineering.

Four articles have already appeared. Subject of the first (May 3, pp. R-258-264) was "Vapor Pressures and Critical Properties of Organic Compounds." The second article (June 7, pp. R-372-375) dealt with "Thermal Properties of Hydrocarbons." "Thermodynamic Properties of Organic Compounds—Estimation from Group Contributions" was the third in the series (July 5, pp. R-476-484). The fourth appeared last month (Aug. 2, pp. R-554-562), "Thermodynamics of Solutions—Ideal Systems at High Pressures."

proach to this problem in which the correction factors are segregated in order that they may be individually expressed in terms of the factors which determine them. It is evident that no single, overall correction factor can be logically applied to the equilibrium constant itself.

The generalized methods for calculating fugacities in order to evaluate activity coefficients are presented as a progress report rather than a finished research. Although these methods are not entirely satisfactory, it is believed that they are sufficiently accurate to be useful for many purposes and no better methods are available.

Because of the tediousness of the calculations involved, Equations 17, 20, and 24 are best used to prepare graphical correlations of ϕ_v and ϕ_l in terms of readily determined variables. Examination of these relationships reveals that for the general case so large a number of variables is involved that complete graphical presentation is hopeless. However, if attention is restricted to a particular system such as mixtures of paraffin hydrocarbons over not too wide ranges of conditions, many of these variables become interdependent and satisfactory correlations may be obtained with only the following:

(a) T_{ci}/T_c', the ratio of the critical temperature of the component to the pseudo critical temperature of the *phase* under consideration.

(b) x or y, the mole fraction of the component in the phase.

(c) T_r', the pseudo reduced temperature of the phase.

The general principles of evaluating ϕ_v by a pressure integration and ϕ_l by a temperature integration are sound and it is believed that greatly improved results will be obtained if an improved modification of the generalized compressibility factor chart can be developed and if sound methods can be devised for calculating pseudo critical properties. Intensive work is needed along these lines.

Availability of Charts

A set of working scale blue prints of the figures in this article may be obtained from the Technical Editor, NATIONAL PETROLEUM NEWS, 1213 West 3rd St., Cleveland 13, at a cost of $.50 to cover printing and mailing charges.

Acknowledgments

The work herein reported was made possible through the support of the Wisconsin Alumni Research Foundation.

Nomenclature

A, B, b = constants in vapor pressure equation
a = activity
f = fugacity
H = enthalpy
H = molal enthalpy
J = mechanical equivalent of heat
K = vaporization equilibrium constant
K' = vaporization ratio = y/x
N = mole fraction
n = number of moles
p = pressure
P = vapor pressure
R = gas constant
T = absolute temperature
v = molal volume
x = concentration in liquid phase (mole fraction)
y = concentration in vapor phase (mole fraction)
z = compressibility factor
γ = activity coefficient due to chemical dissimilarity
λ = molal heat of vaporization
Λ = heat of vaporization
υ = fugacity coefficient = f/p
ρ = density
ϕ = activity coefficient due to dissimilarity in molecular size
$\psi = (J\rho_1/p_c\omega_1)\ (H_{cp} - H)_T$
ω = liquid expansion factor
Π = total pressure

Subscripts and Superscripts

c = critical property
cp = critical pressure
i = i'th component
l = liquid phase
m = mean value
o = absolute zero
r = reduced state
s = saturation value
v = vapor phase
1 = reference state
$'$ = pseudo property
$^\circ$ = ideal state
* = reference state of unit activity

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TECHNICAL MEETINGS FOR OIL MEN

SEPTEMBER

11-15, American Chemical Society, 108th semi-annual meeting, New York City.

11-16, American Association for the Advancement of Science, Cleveland.

OCTOBER

2-5, American Society of Mechanical Engineers, Fall Meeting, Cincinnati.

3-5, National Safety Congress, Chicago.

5-6, American Gas Assn., Chicago.

23-24, American Society of Mechanical Engineers, Fuels and Coal Divisions, joint meeting, Charleston, W. Va.

25-27, American Oil Chemists Society, Chicago.

NOVEMBER

9-10, Society of Automotive Engineers, National Fuel and Lubricants meeting, Tulsa.

13-19, American Chemical Society, 3rd National Chemical Exposition, Chicago.

19-21, American Institute of Chemical Engineers, 37th semi-annual meeting, St. Louis, Mo.

27-Dec. 1, American Society of Mechanical Engineers, annual meeting, New York City.

TIME SAVING COMPUTING INSTRUMENTS FOR SPECTROSCOPIC ANALYSIS

Short Cut Method and Electrical Computers Developed by Oil Company to Lessen Period for Computations

By T. D. Morgan and F. W. Crawford**

To reduce the time consumed in making the intricate computations necessary in the multicomponent analysis of hydrocarbons by spectroscopic methods, a short-cut mathematical method has been developed by one of the large oil companies.

Further, for carrying out the steps of the method, two electrical computing instruments have been developed by the same company. One is to convert spectrophotometer readings to extinctions, necessary only in absorption spectroscopy; the other for solving simultaneous equations of the type encountered in either absorption spectrophotometry or mass spectrometry. The usefulness of the method and the computing instruments has been demonstrated in the company's laboratory.

CHEMICAL PLANTS over the country, having reached an all time high in the production of critical war materials, depend on rapid analytical methods as a guide in keeping "on stream." Successful applications of spectroscopic methods to these analytical problems have shortened the time interval from sampling to completion of an analysis at a big saving in technical manpower.

The principal time consumed now in multicomponent analysis by spectrophotometry is due to the rather lengthy computations. Several short cut mathematical methods have been developed in attempts to reduce further the over-all time for completion of an analysis, but this paper presents a method of demonstrated usefulness as well as a description of electrical computing instruments for carrying out the steps of the method.

One instrument herein described will in principle quickly solve any set of simultaneous equations of the type ordinarily encountered in either absorption spectrophotometry or mass spectrometry. In particular, an instrument for solving 7 equations in 7 unknowns has been developed and its practicability demonstrated in field tests at the Plains butadiene plant laboratory, Borger, Texas. Also, a second instrument has been developed for reducing spectrophotometer data to extinctions.

When an infrared spectrophotometer is used for making analyses of multicomponent mixtures the data consist of galvanometer deflection readings. These deflections are caused by approximately monochromatic infrared light reaching a sensitive thermocouple. Two deflections are read at each pre-selected wave length; one (I_o) with an evacuated cell in the light path and the other (I) with the same cell containing the unknown mixture in the path. The extinction (K) of the absorbing gas is defined as log (I_o/I). The computation necessary to get these extinctions may be done by logarithms, slide rule or by the electrical computing machine explained below in which every mathematical operation in the above computations has an electrical or mechanical counterpart.

By way of illustration, here is a set of simultaneous equations such as are encountered in the process of analysis by infrared spectrophotometry. These equations are set up from instrument calibration and sample data where

x, y, z . . . are per cents of the components of the mixture.

A, B, C . . . are extinction coefficients from instrument calibration,

K . . . are extinctions measured at appropriate wave lengths for a particular sample.

$$A_1x+B_1y+C_1z \ldots . = K_1$$

$$A_2x+B_2y+C_2z \ldots . = K_2$$

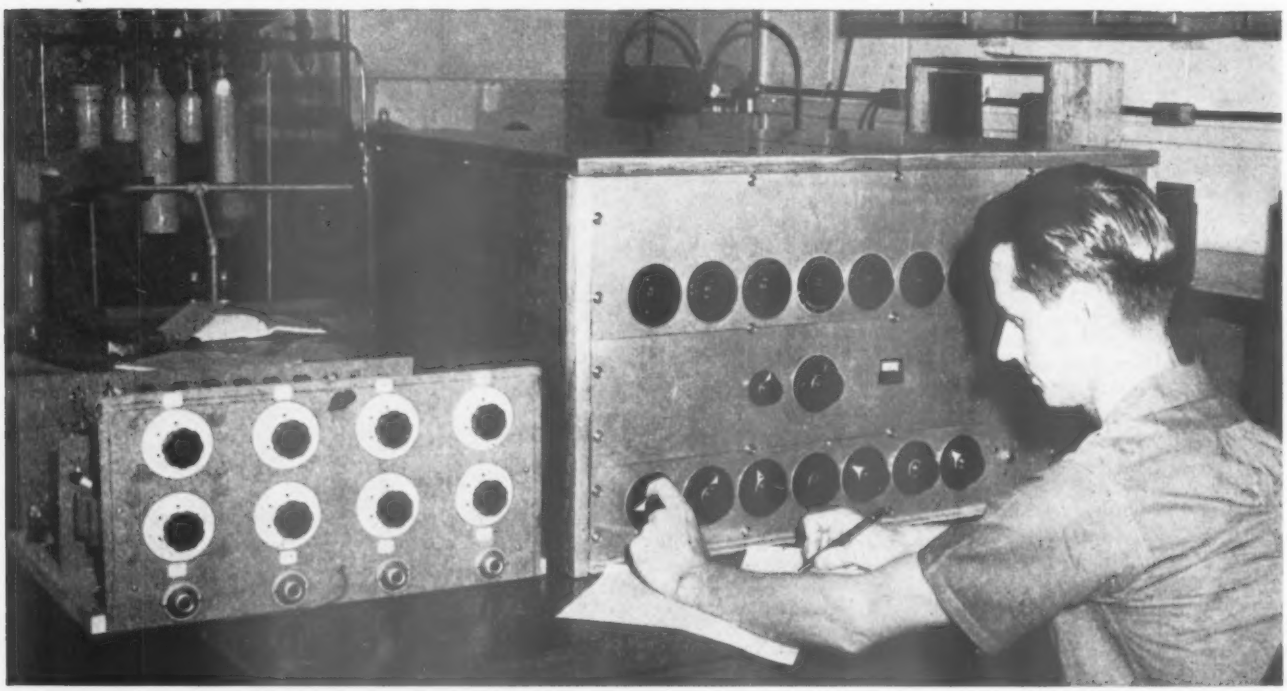
$$A_3x+B_3y+C_3z \ldots . = K_3$$

. . . . . .

. . . . . .

$$A_nx+B_ny+C_nz \ldots . = K_n \quad \ldots . (1)$$

*Research Department, Phillips Petroleum Co., Bartlesville, Okla.



At right, electrical computer, for solving 7 simultaneous equations with 7 unknowns; operated by T. D. Morgan, inventor of the instrument, and one of the authors. At left is a 4-component "breadboard" model

The method and machine of this paper work best when in these equations A_1, B_2, C_3 . . . are large compared to the other constants.

Method of Computation By Successive Approximations

The method of solution herein outlined consists in systematically making successive approximations to the correct solution of the problem. By this method it is first assumed in Equations 1 that the extinctions of all the components except x are negligible, so that to a first approximation $x' = K_1/A_1$. (Primes of the variables x, y, z . . . . will be used to indicate the order of approximation). In the second of Equations 1 assign the value of x' to x and assume that the extinctions of all the components except x and y are negligible so that

$$y' = \frac{K_2}{B_2} - \frac{A_2}{B_2}x'.$$

In the third of Equations 1 assign $x = x'$ and $y = y'$ and assume that all extinctions are negligible except those of x, y and z; then

$$z' = \frac{K_3}{C_3} - \frac{B_3}{C_3}y' - \frac{A_3}{C_3}x'.$$

This procedure is repeated for each equation until a first approximation for each component has been found. A second approximation of x, desigated as x'', is computed by assigning the first approximations to all the components except x, which yields:

$$x'' = \frac{K_1}{A_1} - \frac{B_1}{A_1}y' - \frac{C_1}{A_1}z \ldots .$$

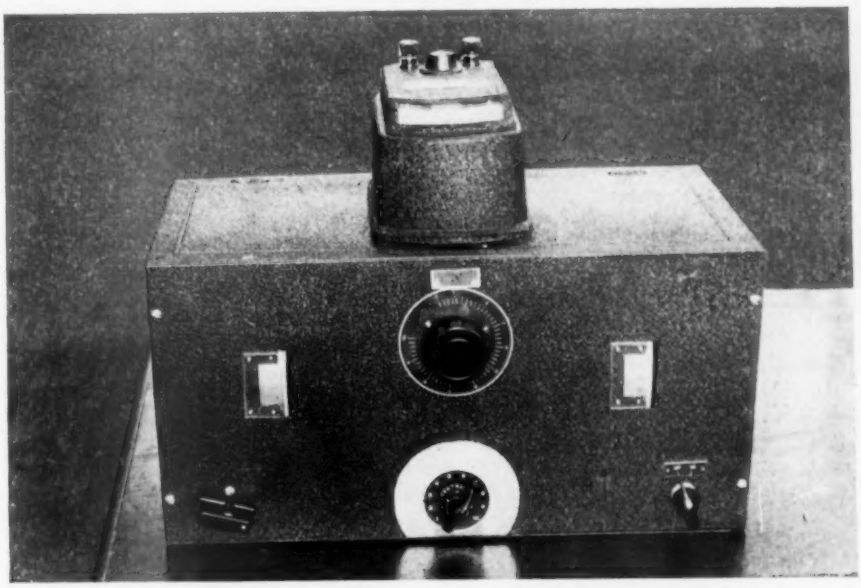
Similarly, a second approximation is found for each component. It will be found that after a few approximations have been calculated, each successive approximation yields values not much different from the answers of the preceding approximation. The experimental errors of the original data determine when it is impractical to carry successive approximations further. The accuracy will usually be of the order of one per cent when the spectrophotometer is of the small routine type.

The mathematical representation of what happens when successive approximations are made is illustrated by a consideration of the following set of two simultaneous equations with two unknowns. A two-equation system was chosen for this presentation for simplicity although the expansion may be carried out for a system containing more than two unknowns with similar conclusions.

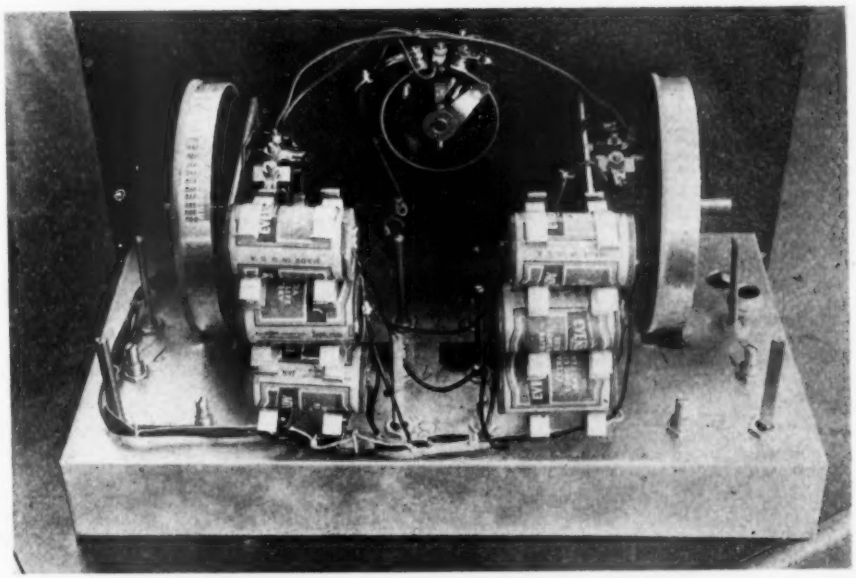
Beginning with x and carrying out a number of successive approximations to y in the system;

$$A_1x + B_1y = K_1$$

$$A_2x + B_2y = K_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$



Electrical instrument to reduce spectrophotometer readings to extinctions



Rear view of extinction computer. Note logarithmic dials for I_o and I

the m*th* approximation of y

$$= \frac{K_2}{B_2} - \frac{A_2K_1}{B_2A_1} + \frac{A_2B_1K_2}{A_1B_2^2} -$$

$$\frac{A_2^2B_1K_1}{A_1^2B_2^2} + \frac{A_2^2B_1^2K_2}{A_1^2B_2^3} -$$

$$\frac{A_2^3B_1^2K_1}{A_1^3B_2^3} + \frac{A_2^3B_1^3K_2}{A_1^3B_2^4} -$$

$$\frac{A_2^4B_1^3K_1}{A_1^4B_2^4} \ldots . + \frac{A_2^{m-1}B_1^{m-1}K_2}{A_1^{m-1}B_2^m} -$$

$$\frac{A_2^mB_1^{m-1}}{A_1^mB_2^m}K_1$$

As a test for convergence in the foregoing series let us consider the ratio of the last term of the series to the next to the last term: $(A_2K_1)/(A_1K_2)$ or substituting equivalent values for K_1 and K_2:

$$\frac{A_2A_1x + A_2B_1y}{A_2A_1x + A_1B_2y}.$$

If this ratio is less than one or if $A_2B_1 < A_1B_2$, the series converges. In the general set of Equations 1 if $A_1 > B_1$, $A_1 > C_1$ . . . . and $B_2 > A_2$, $B_2 > C_2$ . . . . and $C_3 > A_3$, $C_3 > B_3$, the series of successive approximations converge rapidly so that the method yields a sufficiently accurate solution to the simultaneous equations in a few computation cycles. In infrared spectroscopy this means that if wave lengths can be chosen at which only one component causes chief absorp-

tion, then the above method of calculation may be used to advantage.

It is found in practice that the order in which the Equations 1 are placed influences to a large extent the number of successive approximations required to obtain correct answers. While an attempt is made to select a wave length for each component at which only that component causes chief absorption, it is not always possible to do this. Consideration of Equations 2 in the following form will illustrate how the order of calculation changes the number of successive approximations required to obtain a satisfactory solution.

$$x + \frac{B_1}{A_1}y = \frac{K_1}{A_1}$$

$$\frac{A_2}{B_2}x + y = \frac{K_2}{B_2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

In this set of equations if $(B_1/A_1)y$ is very small compared with K_1/A_1 then the first approximation of x is very nearly correct, as also is the first approximation of y.

If $B_1y/A_1x < A_2x/B_2y$, a correct solution to the equations may be found with fewer successive approximations when x' is found first than when y' is found first. Since the variables appear in the above condition, it is necessary to have a rough knowledge of sample composition in order to make the best selection of calculating order.

Electrical Computing Machines

All of the mathematical operations of this computation method may be carried out by the proper addition and subtraction of electrical potentials. We use two machines for this; one to convert spectrophotometer readings to extinctions necessary only in absorption spectroscopy, and the other to solve the resulting simultaneous equations. The first of these, the wiring diagram of which is shown in Fig. 1, is used to take the logarithm of the ratio I_o/I and divide this by a constant. This converts I_o and I readings from the spectrophotometer into K_1/A_1 and K_2/B_2 of Equations 3. To do this, two linear voltage dividers with logarithmic scales are arranged so that the potential of one is subtracted from the potential of the other. (Logarithmic voltage dividers with linear scales could also be used). Referring to Fig. 1 the potential between points 1 and 3 is proportional to log I_o/I.

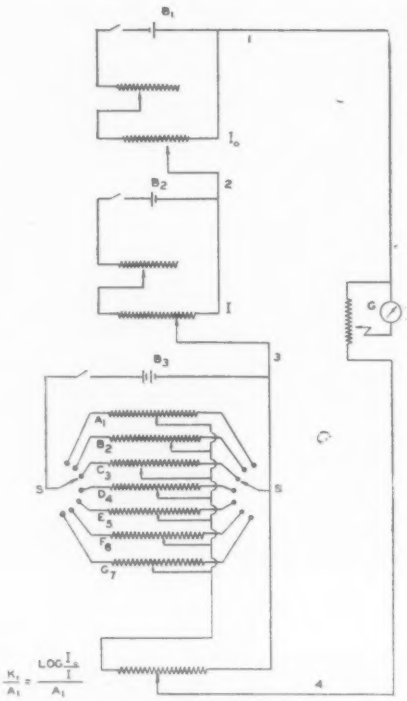


Fig. 1—Electrical diagram of extinction computer

To set the computer for a given value of A_1 it is necessary only to set potentiometers I_o and I at typical values, then set potentiometer

$$\frac{K_1}{A_1} = \frac{\log I_o - \log I}{A_1}$$

and adjust potentiometer A_1 until the galvanometer reads zero. The functional details of this circuit can be followed by a straight-forward application of *Kirchhoff's* laws.

Fig. 2 is a wiring diagram of the electrical computing instrument for solving simultaneous equations. A four-component system was chosen for purpose of illustration although the instrument was actually built for 7 components. In the following set of equations all variables and coefficients are real.

$$w + \frac{B_1x}{A_1} + \frac{C_1y}{A_1} + \frac{D_1z}{A_1} = \frac{K_1}{A_1}$$

$$\frac{A_2w}{B_2} + x + \frac{C_2}{B_2}y + \frac{D_2}{B_2}z = \frac{K_2}{B_2}$$

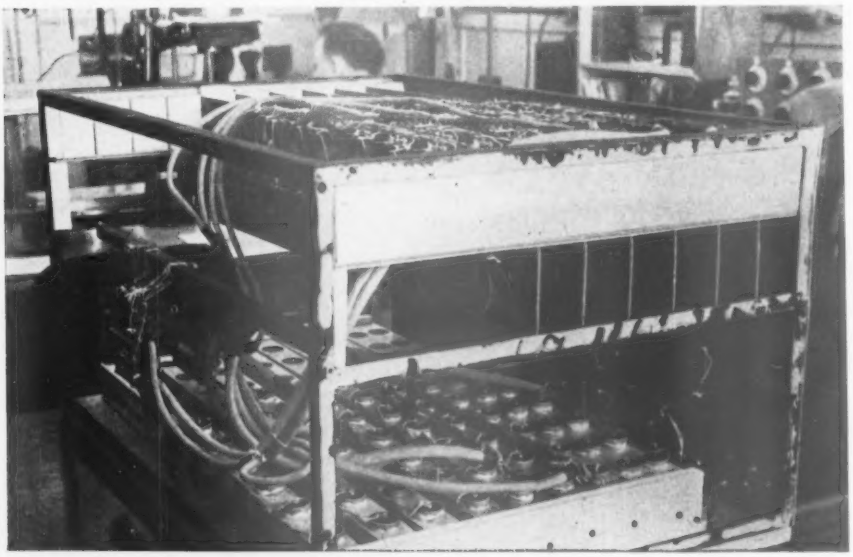
$$\frac{A_3}{C_3}w + \frac{B_3}{C_3}x + y + \frac{D_3}{C_3}z = \frac{K_3}{C_3}$$

$$\frac{A_4}{D_4}w + \frac{B_4}{D_4}x + \frac{C_4}{D_4}y + z = \frac{K_4}{D_4} \qquad \ldots\ldots (4)$$

The A's, B's, C's and D's of these equations are proportional to the extinction coefficients of w, x, y and z respectively, at wave lengths L_1, L_2, L_3 and L_4. K_1, K_2, K_3 and K_4 represent total extinctions of the sample at wave lengths L_1, L_2, L_3 and L_4, respectively. Negative quantities may be handled by the use of reversing switches on the cells of Fig. 2.

Expansion of the computer for use with a greater number of components is straight-forward. For example, to convert the computer of Fig. 2 to one for five components each vertical row of Fig. 2 would be expanded to contain 3 battery circuits (in addition to the K circuits) and there would be 3 vertical rows instead of 4. Referring to Fig. 2, it will be noticed that each vertical row contains 5 cells; the polarity of these cells is dependent upon whether positive or negative terms appear in the equation. Fig. 2 is arranged for all positive terms so the polarity of the potentiometers representing total extinction is the reverse of the polarity of all the other potentiometers.

Each cell is connected across a combination of two potentiometers, each of which is set to a value proportional to its counterpart in the equations. Of each pair of potentiometers the one closest to the cell should be low in resistance compared to the other one for the system to perform exactly according to the theory of the computational method but in the present instrument all the potentiometers are



Side view of 7-component computer with case removed showing battery, slide-wire potentiometers and wiring. Additional dials and space inside the case have been provided to expand the instrument to 10 components

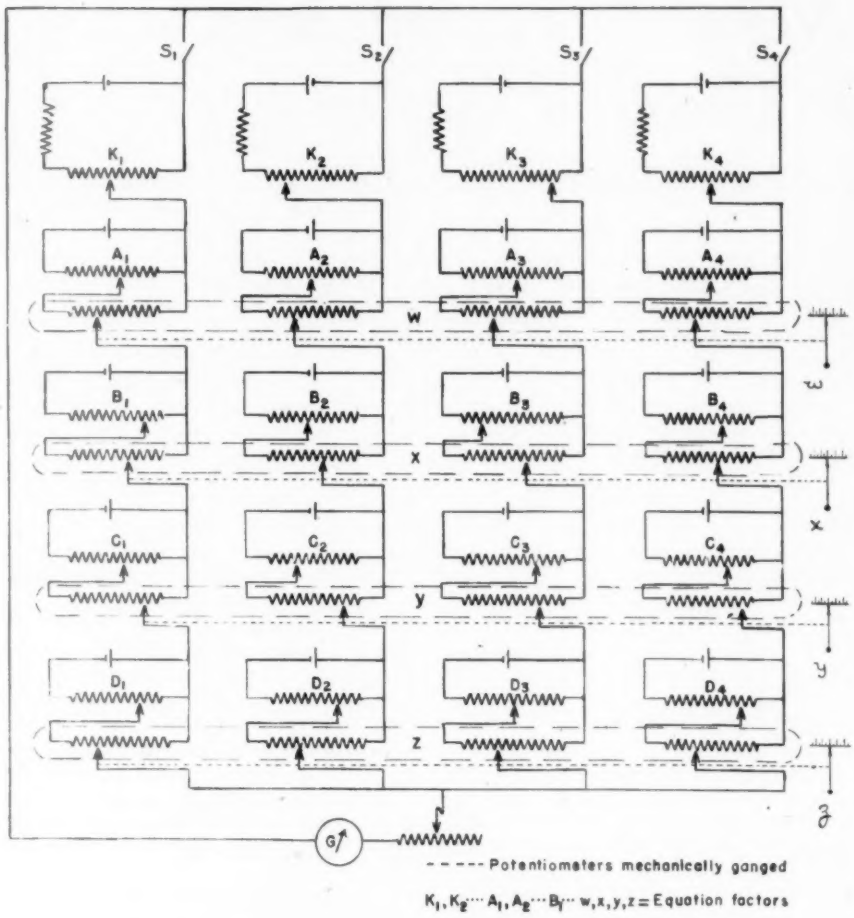


Fig. 2—Electrical diagram of computer for four linear simultaneous equations with four unknowns

alike and no problems have been encountered which would not converge to a solution on the computer. This makes it possible to order a large number of one kind of potentiometer and select the best ones for critical parts of the circuits.

When the total potential from all of the cells of one circuit is zero, indicated by zero galvanometer deflection, the equation represented by the circuit is balanced. When all circuits are in balance, all equations are balanced and the solution may be read off of the dials.

Calibration of the computer of Fig. 2 is done by setting the dials on the "*A*", "*B*", "*C*" and "*D*" potentiometers according to the spectrometer calibration data. This may be done by assuming in Equations 4 that all the variables except w are zero and hence that w equals 100%. The right hand member of each equation is then known and these values are set up on the respective dials of the "*K*" potentiometers in Fig. 2. Each circuit is then balanced by adjusting the dials on the "A" potentiometers. It is next assumed that x is 100% and the "*B*" potentiometers set; then y and z are each assumed to be 100%, while the "C" and "*D*" potentiometers are set.

To use the computer on infrared spectroscopic data, I_o and I are first reduced to extinction and divided by the extinction coefficients of principal absorbers on the computer as outlined above. These values are then equivalent to the right hand members of Equations 4 and are set on the respective dials of the "*K*" potentiometers of Fig. 2. In Fig. 2, switch S_1 is closed and galvanometer G is zeroed by adjusting the dial of the "w" potentiometers. Then S_1 is opened and S_2 is closed and the galvanometer is zeroed by adjusting x. Circuits 3 and 4 are balanced in a similar manner by adjusting y and z respectively.

Returning to circuit 1 it will be found that the galvanometer no longer reads zero when S_1 is closed, so w is again adjusted to balance the circuit. These zeroing manipulations are repeated until the galvanometer reads zero without turning a dial as each switch is separately closed. When this condition has been reached the solution to the set of simultaneous equations may be read directly from the dials w, x, y and z. Each cycle of these manipulations amounts to obtaining an approximation in the computational method above. Seven circuits can be balanced in about one minute and three cycles are usually sufficient to arrive at the answer.

The computation method shown here has been in use for nearly a year. Recently the electrical computing machines were given field tests at the plant and have already saved much time in making analyses.

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Simplification of Valve Types and Sizes Proposed by the Bureau of Standards

PROPOSED SIMPLIFIED practice recommendations for iron and steel relief valves for the petroleum industry, reducing the number of sizes and varieties, have been issued by the National Bureau of Standards of the U. S. Department of Commerce. The accompanying tables Nos. 1-3 contain the recommendations which cover sizes from 1½ to 6 ins. These sizes meet most of the needs in a petroleum refinery.

The recommendations are an outcome of simplification in sizes and types of valves adopted during the wartime plant construction program to aid manufacturers in overcoming a serious equipment bottleneck. They are now promulgated for general postwar needs, to benefit both the oil company users as well as manufacturers.

The recommendations, which oil companies are asked to accept as standard practice, provide that sizes and types of relief valves for pressures and temperatures other than those shown in the tables, or to meet special requirements established by code or law, can be furnished by manufacturers.

This provision, it is said, is intended to allow for refiners ordering outside the recommended list as, for example, for replacements, where the specification needed is not included in the simplified practice recommendation. Some plants now use ring type joints for pressures and temperatures for which raised face valves are specified in the recommendations.

Relief valves for some services not covered in this present recommendation of the National Bureau of Standards are included in its Simplified Practice Recommendation R204-44, Bronze Pop Safety Valves and Bronze, Iron and Steel Relief Valves. This recommendation was issued earlier by the bureau.

The proposed general recommendations for iron and steel relief valves apply to the chemical and other industries as well as petroleum. They were developed at the request of the Shipbuilding Division of the War Production Board, by the Segment Committee of the Valve Industry Advisory Committee, in collaboration with the Construction Division of the Petroleum Administration for War and the National Bureau of Standards.

Purpose and Scope

The following statement of the purpose and scope of the recommendation was issued by the Bureau of Standards, together with the actual recommendations on June 15:

"This recommendation had its origin in a meeting called by the Petroleum Administration for War, held in Washington Jan. 4-5, 1943, of representatives of the petroleum industry, petroleum industry contractors, valve manufacturers and representatives of the PAW and WPB. The purpose of this meeting was to explore the possibility of increasing the production of relief valves through reduction in the number of sizes and varieties.

"Because it was the intention to limit these valves to the needs of the petroleum industry, the simplified list became generally known as "PAW" valves. The tentative simplified schedule was adopted immediately and catalogued by valve manufacturers for regular production to meet the urgent needs of the petroleum industry. However, the production of these valves had to be integrated with the production of other types of safety and relief valves to insure adequate production for all needs. Since these needs were generally in excess of available capacity, simplification of all lines was necessary.

"To accomplish this simplification, the Shipbuilding Division of the War Production Board, which has jurisdiction with respect to these valves in such matters as priority assistance, allotments, allocations, scheduling, etc., appointed a Segment Committee of the Valve Industry Advisory Committee to study all lines and make recommendation for simplification, i.e., reduction of lines to essential items. The Division of Simplified Practice of the National Bureau of Standards was requested to collaborate with this committee and to assist the industry in establishing voluntary simplified practice recommendations for all classes of these valves, including the so-called 'PAW' valves.

"The members of the Segment Committee are: W. E. Leslie, Manning, Maxwell & Moore, Inc., (chairman); Erling Klafstad, Crosby Steam Gage & Valve Co.; A. L. Diederich, Jr., J. E. Lonergan Co.; W. W. Brown, Power Division, Office of War Utilities, Washington.

"Two simplified practice recommendations resulting from the work of this committee have been accepted by producers, distributors and users and prom-

TABLE 1—Simplified Practice Recommendation for Iron Body Valves

Identification No.	Inlet Size Inches	Discharge Area Sq. In.	Max. Service Pressure Psi	Max. Service Temp. °F	Inlet Flange ASA* B16b Psi	Inlet Flange Type of Face	Inlet Flange Gasket Surface	Outlet Flange† ASA* B16a Psi	Outlet Flange† Type of Face	Outlet Flange† Gasket Surface
			SECTION 1, BRONZE TRIM							
11	2	0.785	250 At 400 At	450 or 150	250	RF*	Smooth	125	Flat	Smooth
12	3	1.840	250 At 400 At	450 or 150	250	RF	Smooth	125	Flat	Smooth
13	4	2.853	250 At 400 At	450 or 150	250	RF	Smooth	125	Flat	Smooth
14	6	11.05	250	At 450	250	RF	Smooth	125	Flat	Smooth
			SECTION 2, STAINLESS STEEL TRIM							
15	2	0.785	250 At 400 At	450 or 150	250	RF	Smooth	125	Flat	Smooth
16	3	1.840	250 At 400 At	450 or 150	250	RF	Smooth	125	Flat	Smooth
17	4	2.853	250 At 400 At	450 or 150	250	RF	Smooth	125	Flat	Smooth
18	6	11.05	250	At 450	250	RF	Smooth	125	Flat	Smooth

*The abbreviations B16a and B16b refer to American Standards Assn. specifications; "RF" stands for raised face.
†Each manufacturer shall furnish only one outlet size on a given size and type of valve.

TABLE 2—Simplified Practice Recommendation for Carbon Steel Body Valves

Identification No.	Inlet Size	Discharge Area	Max. Service Pressure		Max. Service Temp.	Inlet Flange[1] ASA* B16e	Inlet Flange[1] Type of Face	Inlet Flange[1] Gasket Surface	Outlet Flange[2] ASA* B16e	Outlet Flange[2] Type of Face	Outlet Flange[2] Gasket Surface
	Inches	Sq. In.	Psi		°F	Psi			Psi		
21	1½	0.307	450	At	800	300†	RF*	Smooth	150	RF*	Smooth
22	2	.785		or		or	RF	Smooth	150	RF	Smooth
23	3	1.840	750	At	450	600	RF	Smooth	150	RF	Smooth
24	4	2.853	450	At	800	300‡	RF	Smooth	150	RF	Smooth
				or							
			750	At	450						
25	1½	.307	720	At	450	300†	RF	Smooth	150	RF	Smooth
26	2	.785		or		or	RF	Smooth	150	RF	Smooth
27	3	1.840	850	At	150	600	RF	Smooth	150	RF	Smooth
28	4	2.853	720	At	450	300‡	RF	Smooth	150	RF	Smooth
				or							
			850	At	150						
29	1½	.307§	500	At	450	300†	RF	Smooth	150	RF	Smooth
210	2	.785§		or		or	RF	Smooth	150	RF	Smooth
211	3	1.840§	600	At	150	600	RF	Smooth	150	RF	Smooth
212	4	2.853§	500	At	450	300	RF	Smooth	150	RF	Smooth
				or							
			600	At	150						
213	4	4.340	400	At	800	300‡	RF	Smooth	150	RF	Smooth
				or							
			600	At	600						
214	4	4.340§	525	At	450	300	RF	Smooth	150	RF	Smooth
				or							
			600	At	150						
215	6	11.05§	250	At	450	300	RF	Smooth	150	RF	Smooth
216	6	11.05	250	At	800	300	RF	Smooth	150	RF	Smooth
217	6	11.05§	400	At	450	300	RF	Smooth	150	RF	Smooth
218	6	11.05	300	At	800	300	RF	Smooth	150	RF	Smooth
				or							
			400	At	650						

*The abbreviation ASA B16e refers to American Standards Assn., specifications: "RF" stands for raised face.

[1] ASA octagonal ring joints are available on all carbon steel valves on inlet only. ASA male face on inlet flange can be furnished when required. Inlet gasket surfaces can be furnished with concentric serrations, 32 per inch, $\frac{1}{64}$" deep, when required.

[2] Each manufacturer shall furnish only one outlet size on a given size and type of valve.

†To be furnished from single pattern with 600-pound ASA standard thickness for either 300- or 600-pound standard. Drilling and flange diameter are the same.

‡When service conditions exceed the listed ASA pressure-temperature rating of the inlet flange shown, a suitable ASA inlet flange will be furnished.

§These valves can be supplied with monel trim for hydrofluoric acid and hastelloy, or other suitable material, trim for hydrochloric acid and similar corrosive services.

TABLE 3—Simplified Practice Recommendation for Alloy Steel Body Valves

Identification No.	Inlet Size	Discharge Area	Max. Service Pressure		Max. Service Temp.	Inlet Flange[1] ASA* B16e	Inlet Flange[1] Type of Face	Outlet Flange[2] ASA* B16e	Outlet Flange[2] Type of Face	Outlet Flange[2] Gasket Surface
	Inches	Sq. In.	Psi		°F	Psi		Psi		
31	2	1.287	800	At	900†	1500	RJ*	150	RF*	Smooth
32	3	2.853	800	At	900†	900	RJ	150	RF	Smooth
33	2	1.287	800	At	1000§	1500	RJ	150	RF	Smooth
34	3	2.853	700	At	1000§	900	RJ	150	RF	Smooth
				or						
			800	At	975§					
35	2	0.785	1625	At	900†	1500	RJ	150	RF	Smooth
				or						
			1800	At	825†					
36	2	0.785	1200	At	1000§	1500	RJ	150	RF	Smooth
				or						
			1625	At	900§					
37	3	1.840	1300	At	900†	1500	RJ	150	RF	Smooth
38	3	1.840	1200	At	1000§	1500	RJ	150	RF	Smooth
				or						
			1300	At	975§					
39	4	6.38	450	At	900†	600	RJ	150	RF	Smooth
310	4	6.38	450	At	1000§	600	RJ	150	RF	Smooth
311	4	6.38	900	At	900†	900	RJ	150	RF	Smooth
312	4	6.38	700	At	1000§	900	RJ	150	RF	Smooth
				or						
			900	At	950§					
313	6	11.05	250	At	900†	600	RJ	150	RF	Smooth
314	6	11.05	250	At	1000§	600	RJ	150	RF	Smooth
315	6	11.05	500	At	900†	600	RJ	150	RF	Smooth
316	6	11.05	475	At	1000§	600	RJ	150	RF	Smooth
				or						
			500	At	975§					

*The abbreviation ASA B16e refers to American Standards Assn., specification: "RJ" stands for ring joint, "RF" for raised face.

[1] ASA raised or male faces are available on inlets when specified. Inlet gasket surfaces can be furnished with concentric serrations, 32 per inch, $\frac{1}{64}$" deep, when reequired.

[2] Each manufacturer shall furnish only one outlet size on a given size and type of valve.

†Plain closed bonnet with screwed or bolted cap, as regularly furnished by manufacturers.

§Closed bonnet with cooling fins and with bolted cap.

The use of fire to produce mechanical energy began with Hero's aeolipile in 130 B. C. Many centuries elapsed before the science of thermodynamics had practical application. Then came the industrial revolution with the greater use and scientific control of fire to serve the arts of manufacture. 20 years ago Alcorn pioneered in research and constructive engineering for the controlled use of heat for the processing of petroleum products. Always abreast of new demands occasioned by new techniques in the industry, Alcorn heater installations are demonstrating their efficiency in leading refineries everywhere. Alcorn Heaters merit the consideration of every refinery which seeks top performance and low operating cost.

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ulgated. These are: Simplified Practice Recommendation R201-43, Iron and Steel Pop Safety Valves; Simplified Practice Recommendation R204-44, Bronze Pop Safety and Bronze Iron and Steel Relief Valves.

"The development of the simplified practice recommendation for the so-called 'PAW' valves was carried along with the others in close co-operation with the Shipbuilding Branch of the War Production Board and the office of the Petroleum Administration for War. These two organizations and the industry were in complete agreement on the need for promulgating a permanent simplification program for these valves to replace the emergency wartime simplification resulting from the conference referred to above.

"Although generally referred to as 'PAW' valves, it will be noted that these valves are suitable for other services. The committee and representatives of the WPB and PAW believe that the simplified list will be adequate for postwar needs and that its general adoption will result in benefits to all concerned."

The statement issued by the Bureau of Standards with the specific recommendations says, under Scope of Recommendation; "The valves in Tables 1, 2 and 3 are primarily intended for air, gas, vapor and liquid service requirements for oil refineries, gasoline plants, synthetic rubber projects and chemical plants; also for general industrial service.

"Relief valves for pressures and temperatures other than those shown in the tables or to meet special requirements, established by code or law, can be furnished."

Under General Construction it is stated: "All valves in Tables 1, 2 and 3 are top guided and have flanged inlets and outlets, side outlet in body, bolted bonnets and enclosed springs."

Specifications for Trim (comprising seat, disc, guide and rings are as follows:

Iron Body Valves: (Table 1) Sect. 1, bronze; Sect. 2, stainless steel.

Carbon Steel Body Valves: (Table 2) Stainless steel. "Monel can be supplied for hydrofluoric acid and similar corrosive services; Hastelloy or other suitable material can be supplied for hydrochloric and similar corrosive services."

Alloy Steel Valves: (Table 3) Stainless steel.

Specifications for Top Construction read: "All valves in Tables 1, 2 and 3 have closed bonnets, sealed caps. Limiting collars will not be furnished because sealed caps make their use unnecessary. Packed or plain lifting gear will be furnished for special services when specified.

"Iron Body Valves (Table 1) and Carbon Steel Valves (Table 2) screwed caps, test gag optional. Alloy Steel Valves (Table 3) screwed or bolted caps, test gag optional."

Under Discharge Areas it is stated: "The discharge areas given in the tables are indices of the relieving capacities of the valves."

Polymerization of Isobutene Over Hydrosilicate Catalysts. III*

By B. A. Kazanskii and M. I. Rozengart**

Author's Conclusions

1. Polymerization of isobutene in the presence of Gayer's catalyst and "solid phosphoric acid" yields products of similar composition, which indicates similar polymerization abilities of these catalysts.

2. Catalysts prepared by the method of Gayer and containing zinc or monovalent thallium are incapable of polymerizing isobutene.

3. A catalyst prepared in the same way and containing thorium actively polymerizes isobutene, but is rapidly poisoned. Its isomerizing ability is weak.

4. Hydrosilicates of metals constituting the carriers of the acid properties of the catalysts serve as the active ingredients in polymerizing catalysts prepared by the method of Gayer.

IN PREVIOUS communications[1, 2] experiments were described by the present authors in which isobutene was polymerized over Gayer's aluminum silicate catalyst at temperatures from 120 to 295°C. Polymerization is accompanied in this case by partial cracking and isomerization of the reaction products, which was directly established for the case of isobutene dimers.

For an appraisal of the ability of the Gayer catalyst to polymerize isobutene, it was of interest to compare the properties of the polymerizate formed in its presence with the product of conversion of isobutene in the presence of phosphoric acid, which is widely used as a commercial catalyst for polymerizing olefins. It was found that the distillation curves of both products of polymerization obtained under close temperature conditions indicate a substantial proximity of their composition, and, consequently, the two catalysts are similar with respect to the character of their polymerizing and isomerizing effects on isobutene.

In their activity these catalysts are also similar. The Gayer catalyst shows a much more rapid fatiguing than the phosphoric acid catalyst and so far it has not been possible to find conditions for its easy regeneration (all experiments were carried out under atmospheric pressure).

The similarity between the polymerizing and isomerizing action of the two catalysts draws attention also to a possible similarity in the mechanism of their action on olefins. Gayer saw the cause of the high polymerizing activity of his catalyst in the combined action of alumina and silica gel and he ascribed to the latter the role of a carrier, i. e., a sorbent which increases the concentration of the initial olefin or facilitates removal of the reaction products from the active centers of alumina. Yet, neither silica gel nor alumina by themselves, nor alumina precipitated on silica gel with the aid of ammonia are good catalysts for polymerization of olefins.

On the other hand, natural aluminum silicates of the type of floridin[4] or Japanese acid clays[5] and synthetic aluminum silicate prepared by Gayer[3] and containing no free alumina easily polymerize olefinic hydrocarbons. This fact, as well as the mode of formation of the Gayer catalyst, lead to a conclusion that the active agent consists of a hydroaluminosilicate distributed on the surface of silica gel and formed by chemosorption of aluminum hydroxide by the silica gel.

It is further necessary to note the Gayer catalyst, just as natural and artificial hydrosilicates, is distinguished by its acid character. It was established[6] that the acidic properties of clays are connected with the presence in them of aluminum and iron; the hydrosilicates behave in many cases as acids[7]. Hydrosilicates of mono- and divalent metals are

*A complete translation from Russian of the original article appearing in Zhurnal Obshchei Khimii (Journal of General Chemistry), Vol. 13, pgs. 304-308, 1943. Translation is by Dr. J. G. Tolpin, Universal Oil Products Co., Chicago.

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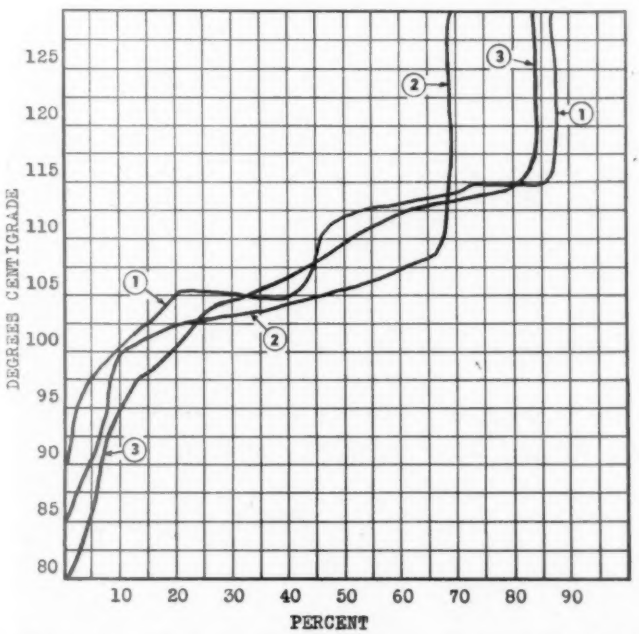

Fig. 1—Distillation curves for products of polymerization, using (1) Gayer catalyst at 218°C., (2) phosphoric acid catalyst at 151°C., and (3) phosphoric acid catalyst at 209°C

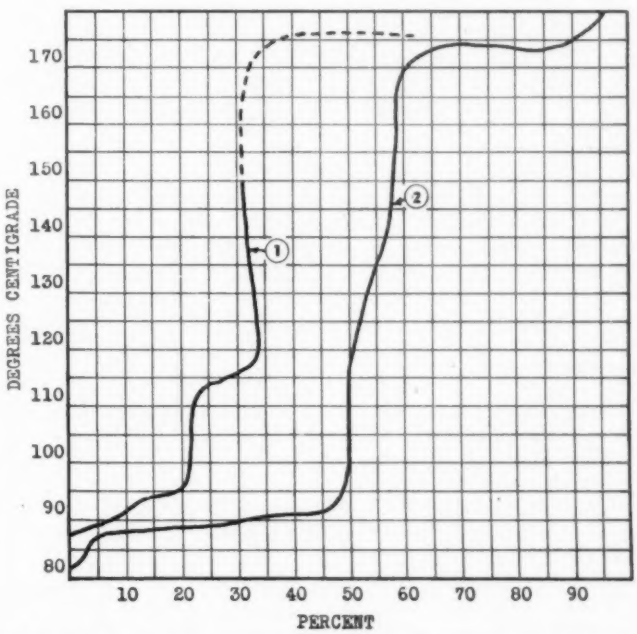

Fig. 2—Distillation curves for products of polymerization, using (1) Gayer catalyst at 120° C. and (2) thorium catalyst at 119°C.

apparently neutral or possess an alkaline character. On the other hand, Gayer showed that hydrosilicates of calcium and magnesium are unable to polymerize propene. Just as inactive were found to be catalysts containing zinc and monovalent thallium prepared by the present authors by the Gayer method.

Correlation of the above observations points to the second conclusion, namely, that the ability of hydroaluminosilicates to polymerize olefins is due to their acidic nature, regardless of the causes of the latter. The mechanism of homogeneous polymerization of olefins by acids, which constituted the subject of a large number of researches, is well understood. In this case, the polymerization occurs through intermediate formation of esters[8, 9, 10] or, according to a recent theory proposed by Whitmore[11], through intermediate formation of an ion of a special type formed by addition of a hydrogen ion at the double bond.

Undoubtedly in the case of phosphoric acid on a carrier the mechanism of polymerization is close to that described by the first scheme, but the acid groups or, from the point of view of Whitmore, the hydrogen ions are localized in the form of active centers on the surface of the catalyst. Because the polymerizing action of aluminosilicate catalysts is caused by the acid properties as mentioned above, the mechanism of this action may be similarly interpreted.

In view of the frequently observed simultaneous polymerizing and dehydrating effects of catalysts, a catalyst was prepared by the method of Gayer containing thorium. It was found to vigorously polymerize isobutene, but only at the beginning of the experiment. In course of time, its activity rapidly diminished.

Despite the comparatively low temperature of the experiment (119°), the catalyst acquired a light brown color which was never observed in the experiments with the Gayer catalyst.

It is interesting that the polymerizate obtained over this catalyst contains almost 1.7 times as much dimers as the product obtained over the Gayer catalyst. This dimer fraction consisted almost exclusively of diisobutene, as far as could be judged from distillation data, which indicates that the thorium catalyst possessed a considerably lower isomerizing activity than the Gayer catalyst or the phosphoric acid catalyst.

Experimental Part

The apparatus and the method of polymerization of isobutene and investigation of the reaction products were described in the first communication of the present authors[1]. Isobutene was prepared by dehydration of isobutyl alcohol over commercial aluminum oxide at 400-410°. Analysis by absorption with 63% sulfuric acid in an Orsat apparatus indicated 97.8-99.5% isobutene in the resulting gas.

Experiments with phosphoric acid catalyst. An imported sample of the commercial "solid phosphoric acid" catalyst was used, consisting of pyrophosphoric acid carried on kieselguhr. Before the experiment, it was dried for one hour in a stream of air at 280°. After experiment 18, it was reactivated with steam and then dried with air at 280°, after which experiment 19 was performed. The products of catalysis were distilled off under a column of 25 theor. plates.

The experimental results are shown in Table 1, where data are also given for the purpose of comparison obtained with a sample of Gayer catalyst at comparable temperatures[1, 2]. The hydroaluminosilicate catalyst is seen to give a higher yield of polymerized products than the phosphoric acid catalyst, despite the fact that with the former experiments were carried out at higher temperatures, which was shown[2] to decrease the yields of liquid reaction products. The rate of formation of liquid products in the presence of the Gayer catalyst rapidly decreases, however, while in the case of phosphoric acid the change is insignificant.

The composition of the products of polymerization is seen from Table 1 and Fig. 1 to be close for the two types of catalyst used, and at higher temperatures octenes, isomeric with diisobutene, are produced in both cases, as revealed by Fig. 1.

Experiments with zinc and thallium catalysts. These catalysts were prepared using the proportions indicated by Gayer: a mixture of 500 ml. silica gel and 250 ml. of a 0.2-normal solution of $ZnSO_4 \cdot 7H_2O$ or $TlNO_3$ was heated for 3 hours on a steam bath and, toward the end, at the boiling point of the solution. The excess of the latter was decanted. The precipitate was washed to remove traces of anion, dried in a drying oven and activated before the experiment by passing air over it for one hour at 350°.

At the beginning of passing isobutene over the catalyst the temperature in the tube rose 30-40°, due to the heat of sorption, after which it rapidly dropped. In polymerization of isobutene over the Gayer catalyst under similar conditions, the temperature of the catalyst rose by

This article is the second of several translations from Russian scientific literature being published in the Technical Section of NATIONAL PETROLEUM NEWS. The first, "Cracking of Kerosine and Gas Oil from Perm Crude with Aluminum Chloride," appeared in the Aug. 2 issue, pp. R-540-544. With the cooperation of the Petroleum Division of the American Chemical Society these articles have been selected from Russian journals as reporting on research work of interest to petroleum technologists in this country. Translations have been made by Dr. J. G. Tolpin of Universal Oil Products Co., Chicago.

The facts and opinions in these translations are solely those of the original authors cited. Universal Oil Products Co. does not necessarily endorse the statements made.

TABLE 1—Experiments with Phosphoric Acid Catalyst

Experiment number	Catalyst	ml. catalyst	Temp. of the expt., °C.	Rate of flow of the gas, liters per min.	Grams isobutene passed	Products of polymerization obtained: Grams	Products of polymerization obtained: Per cent of isobutene	Composition of products of polymerization, per cent by vol.: To 95°C	Dimers 95-120°C	Trimers and polymers above 120°C
19	Phosphoric acid	20	151	0.314	102	61	59.7	8	60	32
18	The same	20	209	0.510	173	84.6	48.8	12	72	16
1	Gayer catalyst	20	120	0.405	51.9	46.7	90.0	0	32	68
2	The same	20	175	0.391	61.6	47.5	72.5	4	62	34
3	The same	20	218	0.375	55.8	32.0	57.3	5	77	18
7	The same	50	218	0.475	266	159.1	59.8	5	82	13

Note—Before each experiment the catalyst was treated with steam.

TABLE 2—Experiments with Thorium Catalyst

Experiment number	Catalyst	ml. catalyst	Temp. of the expt., °C.	Rate of flow of the gas, liters per min.	Grams isobutene passed	Products of polymerization obtained: Grams	Products of polymerization obtained: Per cent of isobutene	Composition of products of polymerization, per cent by vol.: To 95°C	Dimers 95-120°C	Trimers and polymers above 120°C
23	Thorium catalyst	25	19	6.410	53.1	12.7	23.9	1	54.0	45.0
24	The same	25	69	0.368	55.2	2.4	4.3	1	54.0	45.0

Note—The catalyst was regenerated after experiment 23.

almost 100°. The two newly prepared catalysts were unable to polymerize isobutene.

Experiments with thorium catalyst. This catalyst was prepared from 500 ml. silica gel and 250 ml. 0.2-normal solution of $Th(NO_3)_4 \cdot 4H_2O$, as indicated above.

Unlike the previous one, this catalyst was found to be active. When isobutene was passed over this catalyst, the temperature rose by 95-100° and at the beginning of the experiment the intensity of the polymerization was not less than that of the Gayer catalyst, but its velocity began to diminish rapidly, due to the poisoning of the catalyst by the high molecular polymerization products.

Attempts to revivify the catalyst with moist air at 550° were unsuccessful. The total yield of the liquid product of polymerization was considerably lower than in the case of the phosphoric acid catalyst or the Gayer catalyst, as seen from Table 2.

The distillation curve of the products of polymerization obtained over the thorium catalyst is shown in Fig. 2. It differs greatly from the distillation curve of the products of polymerization obtained over the Gayer catalyst, in that the product contains 1.7 times as much of the dimer fraction, consisting almost exclusively of diisobutene.

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Correction

In the article entitled "Laboratory Method for Determining the Activity of Cracking Catalysts", Aug. 2d Technical Section, p. R-538, bottom of the first column, it was stated; "Air and H_2 are introduced into the reaction chamber through a gas manifold." This was in error and the sentence should read "Air and N_2 are introduced into the reaction chamber through a gas manifold."

BOOKS FOR REFINER

Standards for Mineral Wool Insulation

Following two years of work by the Specifications Committee of the Industrial Mineral Wool Institute in cooperation with the National Bureau of Standards, a 30-page Commercial Standard, CS 117-44, "*Mineral Wool: Blankets, Blocks, Insulating Cement and Pipe Insulation for Heated Industrial Equipment*" has been published by the Government Printing Office.

The Standard is primarily designed to afford consumer protection through both its material and installation specification requirements. Clear explanations and 19 illustrations tell the step by step procedure to be followed in installing mineral wool products, separately or in combination. Also included are tables for the different forms of insulation, giving thickness recommended to take care of operating temperatures up to 1600°F.

Copies of CS 117-44 will be supplied without charge by the Industrial Mineral Wool Institute, 441 Lexington Ave., New York 17, or can be obtained for $.10 each from the Supt. of Documents, U. S. Govt. Printing Office, Washington 25.

Data Book on Seamless Steel Tubing

Seamless Steel Tube Data, a reference handbook for manufacturers and users of equipment employing carbon-steel and alloy tubing, has just been published by the Seamless Steel Tube Institute. The book, assembled in a loose-leaf binder, is essentially a collection of pertinent data charts and tables, pretty well covering the seamless steel tube field.

Of primary interest to refinery engineers is the section on "Pressure Tubing," which includes material on boiler tubes, heat exchanger and condenser tubing, still tubes, alloy pipe specifications, and stainless tubing. In addition, there are discussions of the metallurgy of alloy addition for improving high temperature properties and of galvanic action.

Other sections deal with mechanical tubing, standard steels, shapes and forms. A glossary of definitions and 86 pages of common reference tables are also included.

The book is clearly printed, and quite visibly indexed throughout.

Copies of *Seamless Steel Tube Data*, 321 pages, 8½ by 11, flexible loose-leaf binder, can be obtained through the Book Department of NATIONAL PETROLEUM NEWS, 1213 West Third St., Cleveland 13, for $2.50.

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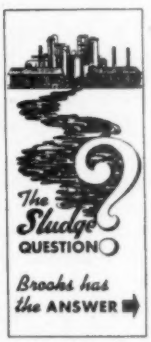

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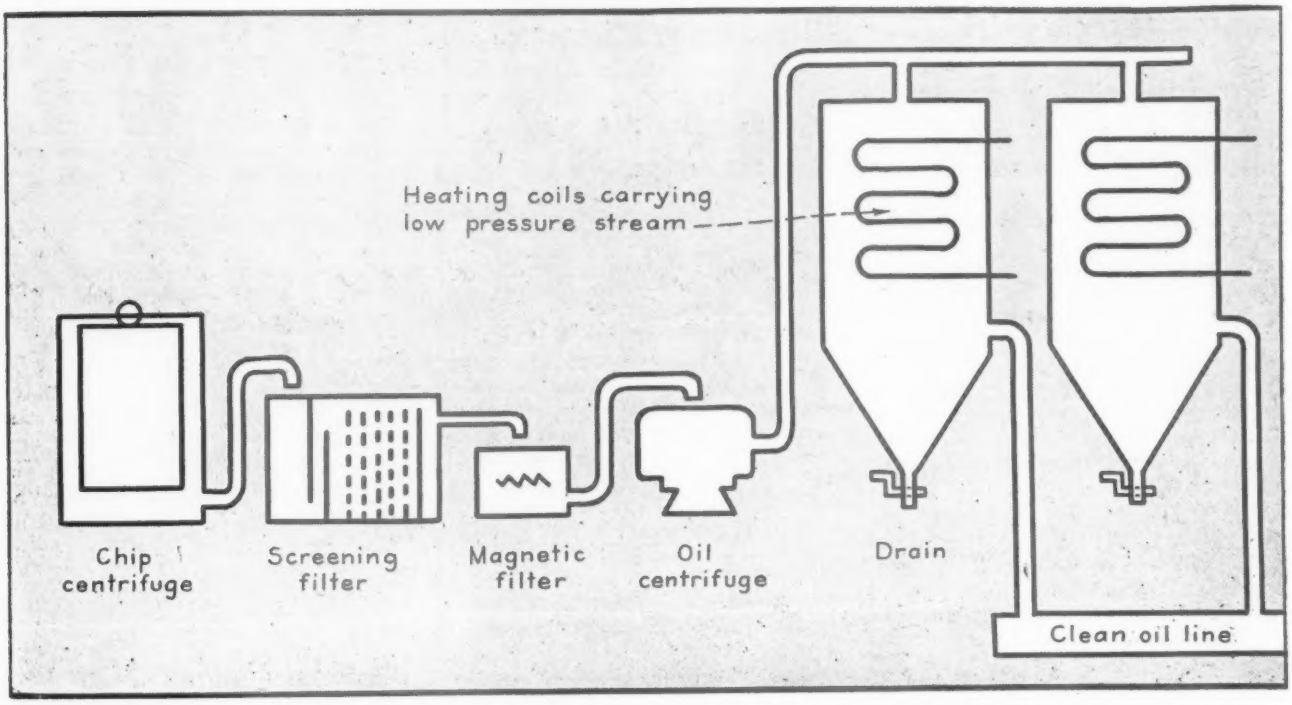

Fig. 1—Apparatus for reclaiming cutting oil which is also used for lubrication

Method for Filtering Dual-Purpose Industrial Lubricating Oils*

*By W. G. Forbes***

The essential properties required of cutting oils which are also used for lubricating automatic machines are described. Where an excess amount of used oil tends to accumulate, it may be desirable to filter the used oil and return it to the lubricating system. A practical method for filtering is described. The filtered oil should be tested for abrasive impurities by the ash test.

AUTOMATIC screw machines, and similar special machines, are generally equipped with circulating oiling systems or mechanical lubricators for bearings, driving gears, cams and other parts which comprise the operating section.

On multi-spindle machines, it is often difficult to seal each spindle completely and prevent leakage of the machine oil into the cutting oil. If leakage causes enough dilution to interfere with the cutting operation, it is best to use cutting oil in the lubricating system. This can be done without sacrifice of good lubrication because bearing and gear tooth pressures in automatic machines are comparatively light and if the cutting oil has a Saybolt viscosity of 100 seconds at 100° F. or above, there need be no fear of damage to operating parts.

When using cutting oil for a dual purpose, it is necessary to use a base oil that is non-corrosive as, for example, grades wherein the extreme pressure element such as sulfur is properly combined with a fatty oil, or other suitable carrying medium, before it is blended with light mineral oil.

Cutting oil used for a dual purpose may tarnish bronze bushings but this effect must not be confused with actual corrosion. Chemical reactions which produce tarnish and corrosion are similar, but very often there is a difference in the physical result. Tarnish must not be confused with corrosion when considering the use of a dual-purpose oil. In this connection the copper strip test, and variations, are sometimes used to throw suspicion on the practice of using suitable cutting oils as lubricants in automatic machines.

However, these technical objections have no basis in fact, providing the cutting oil is not actually corrosive, because a slight tarnish on bronze bushings will do no harm. When the automatics are equipped with ball or roller bearings there will be no trace of tarnish if ingredients in the cutting oil are properly combined.

The copper strip test referred to determines the presence of materials which cause tarnish or corrosion. In practice a polished copper strip is placed in a bath of the oil under test and the temperature maintained at 212° F. for 3 hours. At the end of this period the copper strip is examined and its appearance reported as negative, slight discoloration, heavy discoloration, black, or whatever it may be. The test is simple, and the ideal result is, of course, negative.

Copper Test Not True Indication

This test does not identify ingredients which may be producing tarnishing or corrosive action, nor does it indicate their possible degree of corrosiveness on other metals and alloys. However, it may be stated that all properly refined straight mineral oils will show a negative result, and compounded cutting oils should register no more than a very slight discoloration if they are to be used for lubricating bearings, gears and cams on automatic machine tools.

It is interesting to note that an almost microscopic percentage of free sulfur in any cutting oil will react on the strip. Furthermore, other types of compounds may be found which do not tarnish the strip to any noticeable extent but they may form a minute quantity of metallic salt. This entire subject is a matter that should be taken up with the supplier of the particular cutting oil rather than placing complete reliance on the copper strip test.

Occasionally, special automatics are designed to operate under heavy bearing and gear pressures, but these machines are exceptions. Even so, the

*From American Machinist, April 13, 1944.

**Industrial Products Dept., Tide Water Associated Oil Co.

viscosity of the cutting oil can often be raised and a satisfactory compromise effected to satisfy both requirements. In this connection it is seldom necessary to raise the viscosity of the dual-purpose oil above 200 seconds at 100° (Saybolt) or above an S.A.E. 20 rating at the maximum.

Oil Loss May Be High

When operating a number of automatic screw machines the loss of oil from the lubricating systems may be quite high. This oil enters the cutting oil systems where much of it is carried away and lost by clinging to chips. Often this loss is not sufficient to balance the make-up that must be added to the lubricating system. Consequently, an excess amount of used oil tends to accumulate over a period of time. If chip loss just about equals make-up, then it is a simple matter to add new cutting oil to the lubricating systems. Where excess is appreciable, steps must be taken to filter used oil and return it to the lubricating system. This procedure requires careful consideration when selecting filtering equipment, otherwise the used oil may cause operating difficulties by causing premature wear.

There are several ways in which used cutting oils may be filtered. One effective method is to run the oil through chip centrifuges; then *slowly* through a roomy tank equipped with 600 - mesh removable screens; next through a magnetic filter; through an oil centrifuge and on to vertical cone-shaped rest tanks equipped with heating coils to sterilize oil against dermatitis bacteria. At the same time oil is thinned to a point where any remaining impurities will free themselves and sink to the bottom of the cone-shaped tanks. A schematic view of a complete system designed along these lines is shown in Fig. 1.

Simple to Operate and Maintain

This type system has the advantage of being simple to operate and maintain. The screening tank and magnetic filter eliminate much of rough materials and, incidentally, aid in reducing wear and tear of the oil centrifuge parts. Heating coils in the rest tanks sterilize the oil and aid in freeing oil from everything that has a higher specific gravity. The cone-shaped design collects these materials at one point where they can be drained off.

Oil in the rest tanks should be brought to a temperature of between 145° F. and 165° F., held there for a half hour, then allowed to cool and settle for at least three days. At the end of this period, oil will be sterile and free from the finest abrasive impurities. It is important that the heating operation be carried out below 180° F. as excessive heating tends to decompose compounds in cutting oils and produce unnecessary and detrimental deposits. Oil must be allowed to rest for a sufficient period of time after shutting off the heat, because it may take 24 hours for the circulating currents to die out in a large tank. This method of filtration is slow, but is one of the surest and most effective known.

Filtered oil should be tested for impurities by employing the ash test. This procedure will disclose the presence of abrasive materials. This test generally requires an experienced observer to make correct interpretations, particularly if materials of an abrasive nature are found and require identification, or if further steps have to be taken to assure their elimination. As the name implies, the ash test is carried out by burning all combustible products from a sample of 20 grams. The test may be specified for new oils, as well as for verifying the presence of abrasive materials in used oils.

In practice the sample is heated in an open crucible until the oil can be ignited and allowed to burn away. The residue may then be placed in a muffle furnace to eliminate any remaining carbonaceous material. The remains will be ash content which is expressed as a percentage of the original sample. For example, the ash content of a used oil might be 0.12 which would be very detrimental if the used cutting oil was being returned to the lubricating system of automatic screw machines. In fact, if machines are equipped with ball or roller bearings, oil will destroy their accuracy in a few months if the ash content were 0.10 during their useful life. Sometimes it is necessary to verify materials in the ash, but generally ash content of used cutting oils is composed of metallic particles. When cutting oil is new, there should be no ash content.

Fuller's earth, different types of diatomaceous earth and filtering clays are not generally suitable for purifying cutting oils because the fatty oil compounds tend to clog tiny canals and surfaces of each particle rapidly and the filtering medium becomes inoperative. However, clay type percolating filters are very effective with straight mineral oils. When selecting filtering equipment of the centrifuge type, it is best to install large units and run the oil through at approximately half the rated capacity as centrifuges are much more effective, if operated below volumetric capacity.

There are several types of filters, sterilizers, and purifying combinations which may be used effectively, but regardless of the equipment employed, it is important to test the filtered oil at intervals and not operate the system "blind" from year to year. An improperly operated filtering operation can be very costly in repairs and renewals, particularly when using cutting oils for a dual purpose.

(*Continued from p. R-575*)

a dozen or more secondary products, and from these perhaps hundreds of tertiary and higher reaction products and by-products.

A chemical reaction very seldom produces a single product. Usually there are at least two different substances produced, and often more. This not only makes it necessary to purify the desired reaction product, but it leaves at least one or more products whose disposition must be considered, whether wanted or not. Byproducts cannot usually be thrown on the countryside because of the injurious effects produced. Many research laboratories have labored as hard and long over what to do with a byproduct, as over the essential reaction by which products and byproducts are produced.

2. The chemical industry has been a profitable one and indications are that it will continue to be an industry of relatively high profits and, also, of a high rate of change. The feature which makes both change and profits possible is the great possibility for diversification. The actual development of new products and processes takes place in the research laboratories of the chemical industry.

Competition within the industry is between different processes and different products competing for the same use: very rarely is it price competition between rival producers of the same material made by the same process. Technical competition is exceedingly keen, but pressure-selling, price-cutting, and labor-sweating are not generally employed.

3. The inorganic and heavy chemicals industry is an older, larger volume, and probably lower profit industry than the younger, rapidly expanding organic chemicals industry in this country.

The synthetic organic chemicals industry, on the other hand, was born in this country about 25 years ago and it is even now in the process of a breath-taking expansion. Of the various source materials for organic chemicals, it appears unlikely that there will ever be a better source than petroleum. The next 10 - 20 years may well be spoken of as the "Petroleum Era". However, the utilization of petroleum and coal for chemicals will always be negligible with respect to their utilization for power.

4. The chemical industry produces chemicals which are used in the manufacture of every kind of product. The chemicals, however, often do not appear in the final product; they are producer's goods, sold, for the most part from chemical manufacturers to other manufacturers, including other chemical companies. The industry has met the challenge of World War II for new processes and expanded production; at the end of the war there is little doubt that in serving all other American industry, the American chemical industry will be *the basic industry* of the American industrial economy.

WIDENING HORIZONS

Views on Personnel, Management and Economic as Well as Technological Developments in Petroleum Refining and Natural Gas Processing: Comment from Readers Is Invited

Co-operative Analytical Control Research Should Not Be Dropped

THE WAR has placed great emphasis on the value of having reliable, accurate methods for analytical process control in the plant as well as for analysis of the finished products. This is especially true for the new and highly technical processes producing pure chemical compounds or mixtures of a few such compounds which have been developed during the war emergency.

"T.A.C.", the Technical Advisory Committee of the Petroleum Industry War Council, has done a notable job of developing "best methods" and alternative "rapid methods" for many analytical control tests connected with production of wartime petroleum products for which there was no "standard" method available.

The pooling of data from research laboratories of many oil companies, developed from analytical investigations individually inaugurated several years ago, prevented duplication of effort and saved much time in developing analytical and process techniques to meet the emergency wartime demands.

It is accepted that certain types of technological developments can only be carried on co-operatively in wartime. Individual company interests in normal times would prevent their making available results of developments in new processes to all others, for example. Also, the combining in such investigational endeavors might be considered as in restraint of trade and involve the companies participating, particularly under the interpretation of the anti-trust laws by the present administration.

This objection, however, is not valid for work done in product or intermediate-product analysis for plant control work and marketing purposes. The public as well as industry interests are well served by uniform methods of analysis for product control. The crude methods and slap-dash techniques of yesterday's purposes will not suffice for today's and tomorrow's products from petroleum.

Harry Levin, of the Texas Co.'s research staff, and chairman of T.A.C.'s analytical subcommittee, made the following statement in a report at the last annual meeting of the American Petroleum Institute: "The newer plant processes create new problems for the analytical chemist. Though a difference of 5° F. in the result for end point of motor gasoline was within the accepted tolerance of the established method of test, the operators on toluene units now are disturbed by 2° F. differences. Whereas slight difference in olefin or diolefin content still left you with a product that could be sold and would run your car, it may now leave you with a batch of toluene entirely unacceptable, requiring re-treating or re-running before disposal.

". . . The best possible analytical methods are absolutely necessary to insure the proper application of the newer operating techniques and the proper utilization of the more fully developed older operations."

If P.I.W.C., its committees and subcommittees disband shortly after hostilities cease, this would automatically put an end to its Technical Advisory Committee and its co-operation. It should, however, be the task of the American Petroleum Institute through its co-operative projects, the American Society for Testing Materials, or others, to see that T.A.C.'s program of co-ordinating analytical techniques for process and product control to produce "best" and "rapid" methods appropriate to the need is continued.

A step in this direction is the consideration by the A.P.I of a proposal to develop and supply pure hydrocarbons for calibration of spectrometers, such as the infra-red, ultraviolet and Raman instruments, which are used in the synthetic rubber and allied war-products plants. Nationwide "clinics" have been held on the proper techniques for setting up and using these instruments in petroleum plants producing raw materials for these products. It would seem appropriate that continued experimentation to keep analytical control techniques apace of technological developments would be a logical expansion of this project, or warrant creation of a separate project for this purpose.

The Research Into Alternate Liquid Fuel Sources Broadens

There is much logic to the suggestion of Dr. Robert E. Wilson that a group or committee of the industry's leading technologists advise and co-operate with the Bureau of Mines in its coming investigation of non-petroleum sources for liquid fuels. (See p. R-596)

This is no new subject for the oil industry. It is safe to say that there is hardly a large oil company that has not carried on research on some alternate source for motor fuel or other product, the enthusiasm and extent of the work in any period reflecting on how long it was believed, at the time, that our petroleum reserves would be a sufficient source of supply.

Also, since the group which has zealously advocated for many years the manufacture of alcohol from agricultural products for motor fuel has succeeded in including this field in the research about to be started, it is altogether fitting that the oil industry should participate. Oil has more at stake than any other industry in the development of new sources of supply, since the oil companies will likely make and distribute motor fuel and other products whether produced from petroleum or other sources.

It may still be news to many in the petroleum industry that the research project, as approved by Congress and enacted into law, (originally the O'Mahoney oil-from-coal measure) includes the study of the production of liquid fuels from agricultural and forestry products. As originally proposed only coal and shale were to be investigated. The public hearings were on this basis. Then the lobbyists for alcohol motor fuel became active. On March 28 the report of the conference committee presented to the House disclosed that the conference committee had agreed to include agricultural and forestry products. This part of the investigation is to be carried out under the direction of the Secretary of Agriculture. There is no record of any hearings on the merits of this proposal. The bill was passed and signed by the President early in April.

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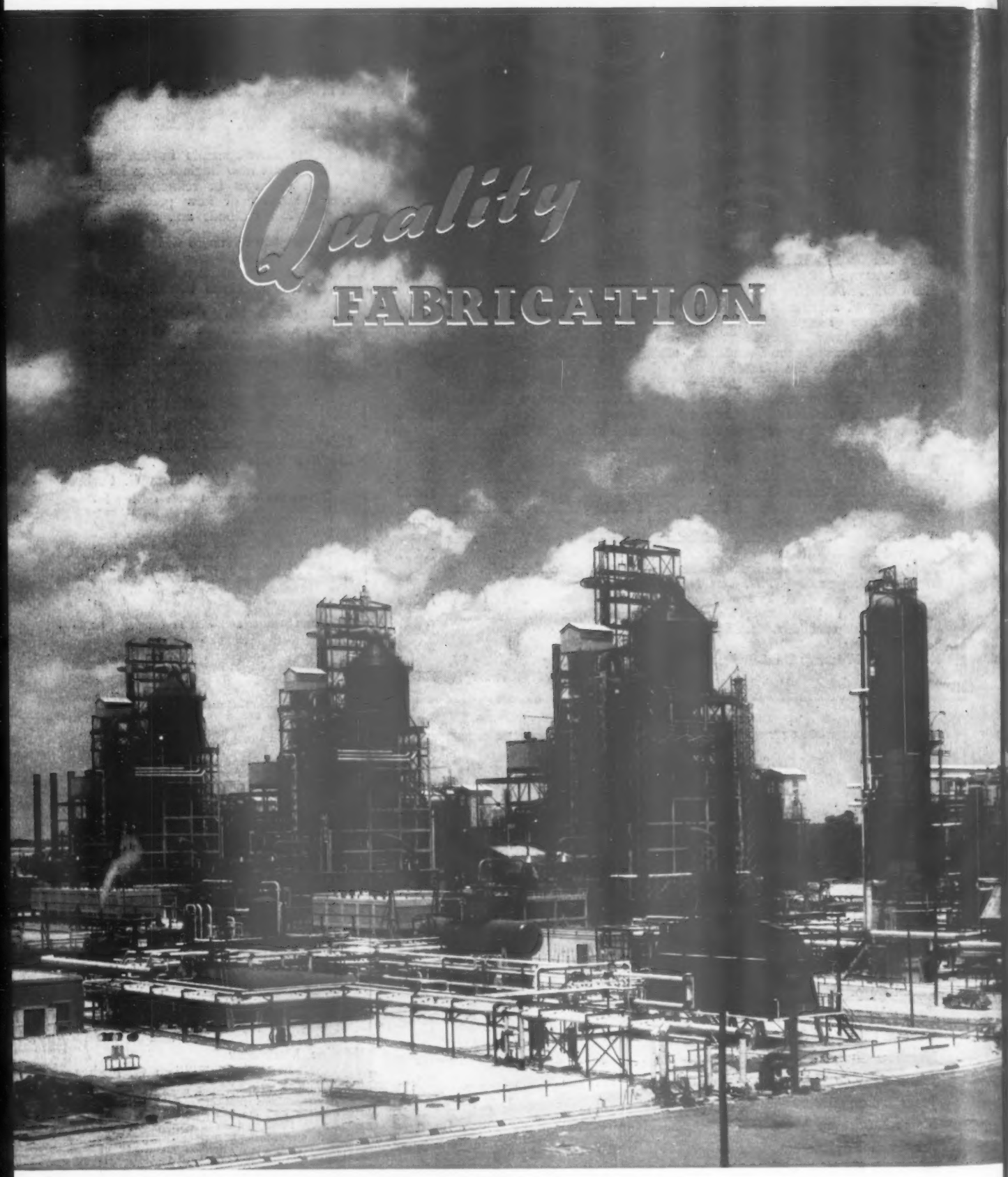

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